

RECONNOISSANCE SOIL SURVEY OF NORTHEASTERN WISCONSIN.

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DESCRIPTION OF THE AREA.

LOCATION AND BOUNDARIES.

The area included in the reconnaissance soil survey of northeastern Wisconsin, as implied, is located in the extreme northeastern part of the State. It is made up of the six counties of Forest, Florence, Marinette, Oconto, Langlade, and Shawano, and comprises an area of 6,098 square miles, or 3,902,720 acres. The territory covered by the survey has a somewhat unsymmetrical outline, owing to the irregular shape of some of the counties and to the fact that a portion of the boundary consists of water courses. The area is bounded on the north and on most of the east side by the Upper Peninsula of Michigan, most of the boundary being formed by the Brule and Menominee Rivers. For a distance of about 40 miles the waters of Green Bay border it on the southeast. The area is bounded on the south by Brown, Outagamie, and Waupaca Counties, and on the west by Vilas, Oneida, Lincoln, and Marathon Counties. Its length from north to south is about 100 miles, and its width from east to west about 87 miles. Marinette, the largest city, is in practically the same latitude as Bangor, Me., Alpena, Mich., Minneapolis, Minn., Sheridan, Wyo., and Salem, Oreg. It has the same longitude as Mobile, Ala., and Evansville, Ind.



FIG. 41.—Sketch map showing location of the reconnaissance survey of northeastern Wisconsin.

A soil survey of Marinette County was made in 1909 by Dr. Samuel Weidman, of the Wisconsin Geological and Natural History Survey, and Percy O. Wood, of the United States Department of Agriculture, and the information gathered in that survey has been incorporated in the present report. It was considered advisable to include Marinette County in the present survey in order that a treatment of the

whole of northeastern Wisconsin might be available in one complete soil map and report. No additional work was done in Marinette County, but after field inspection the various soil types were correlated with soils in the adjoining counties.

TOPOGRAPHY.

The predominant feature of the topography of this area taken as a whole is a plain. The variations from a general plainlike surface are not numerous and consist of rounded hills rising rather abruptly from the surrounding country. The plain is the product of, and exhibits the features resulting from, glacial action with no essential modification from other agencies. It slopes from northwest to southeast, lying at about 1,600 feet elevation in the northwestern part of the area and at a little less than 600 feet along Green Bay in the southeastern part. While erosion has been at work on this surface since its rather recent construction, the results effected are practically negligible, though they are a little more prominent in the southwestern corner of Langlade County than elsewhere.

The surface is a constructional one and shows the characteristic features resulting from ice action and that of the water bodies associated with it. The greater part of the surface is morainic, consisting of an uneven surface, broadly rolling or undulating in the eastern and southeastern part, as a rule, and very rough, in miniature, in the western and northwestern part of the area. The distribution of surface inequalities is wholly without system or regularity, resulting in the formation of low hills and shallow basins of all shapes, the latter often without outlet. While the distribution is intricate the strength of relief is not great. There is rarely a difference of 100 feet in elevation between neighboring low and high points. Scattered through the area are many smooth tracts from one to several square miles in extent. The drainage system in this whole region is imperfectly developed.

In the southwestern part of Langlade County there is an area differing from the remainder in the detail of its surface but not to the extent of a divergence from the general form of a plain. In this area, which includes the land mapped as Spencer silt loam, the topography is undulating or rolling, with rounded outline and a rather systematic distribution of its features. There is a rather well developed drainage system which has determined the type of topography, making it rather maturely but very faintly dissected.

The region around Antigo consists of a large flat with practically no relief except an occasional sharply cut but very shallow and narrow valley. It belongs with the group of smooth areas in the western part of the county, differing from them, as far as topography is concerned, chiefly in its size.

The plain surface is interrupted by isolated hills and ridges rising sharply above it to a maximum height of about 500 feet. They consist of parts of an old, hard, rock topography that project above the plain whose materials have buried to varying depths the less pronounced parts of the old surface. They are confined to one well-defined belt which extends southwestward into the northeastern part of the area, terminating in the neighborhood of Mountain and to shorter projections northwest of this, none of which reach far across the State line. The most prominent of these hills are shown on the soil map by rock-outcrop symbols.

DRAINAGE.

About 8 per cent of the area surveyed lies within the Mississippi River basin, and the remainder drains into Lake Michigan. The extreme western part of Langlade County is drained to the south and southwest by the East and West Branches of Eau Claire River, Spring Brook, and Pine River into the Wisconsin River. A part of the extreme northwestern section of Forest County is drained into the Wisconsin River through a few small streams which rise near the county line.

There are two Pine Rivers in the area, one of which empties into the Wisconsin River and the other into the Menominee River.

The Menominee River, with its branches, including the Brule, Pine, Popple, Pike, and Wausaukee Rivers, drains a large part of northern Forest County, all of Florence County, and more than half of Marinette County. The Peshtigo River, which enters Green Bay about 8 miles below the mouth of the Menominee River, drains a large portion of central Forest County and most of the southern part of Marinette County. Its chief tributaries are the Rat, Otter, Thunder, and Little Peshtigo Rivers. The Oconto River, with its branches, drains southern and southeastern Forest County and all of Oconto County except about four townships in the southeastern part, and enters Green Bay at Oconto. The Pensaukee, Little Suamico, and Suamico Rivers rise in eastern Shawano County and flow in a general easterly direction across southeastern Oconto County into Green Bay. They are relatively small and unimportant streams. The remainder of the area, consisting of southwestern Forest, eastern and northern Langlade, and all of Shawano County except the three eastern townships, is drained by the Wolf River and its tributaries, chief among which are the Lilly, Red, and Embarrass Rivers. The Wolf flows in a southerly direction, but receives most of its tributaries from the west. It flows south from Shawano for about 80 miles, and finds its way into Green Bay through Lake Winnebago and the Fox River.

The various rivers offer good opportunities for the development of water power, and a number of plants have been installed. From

the north line of Langlade County south to the town of Shawano, a distance of less than 80 miles, the Wolf River has a fall of 774 feet. The Oconto River in its course of 87 miles within the area has a fall of 945 feet. All the numerous streams which have their sources in the high, plateau-like crystalline-rock region of northern Wisconsin and reach outlets at the level of the Great Lakes necessarily have a rapid fall.

POPULATION.

The earliest known white settler in the area surveyed was an agent of the American Fur Co., who located at the present site of Marinette in 1796. The first permanent settlers were attracted to this region by the lumber resources. The first sawmill was located at the present site of Marinette in 1832. Marinette County was organized in 1879 from a part of Oconto County. The original plat of Marinette was laid out in 1858. A settlement was started at Pensaukee, in Oconto County, in 1829, and a sawmill was erected at Oconto about 1835. A mill was put into operation at Oconto Falls in 1846. Oconto County, which was the largest in the State, was organized in 1851. Until 1857 it was joined to Brown County for judicial purposes. The first settlement in what is now Shawano County was made in 1843, when a mill was built on the Wolf River at the present site of Shawano. Shawano County was organized in 1853, and for a time was joined to Outagamie County. The Menominee Indian Reservation, including territory now in Shawano and Oconto Counties, was established in 1848. Antigo, the county seat of Langlade County, was founded in 1877 and platted two years later. As early as 1871 a settlement was established on the Military Road in what is now eastern Langlade County, and in 1876-77 a settlement was established at Phlox. Forest and Florence Counties were the last in the area to be settled. There was little trading with the Indians in Forest County before 1850, when a trading post was established on Pine Lake. In 1868 a settlement was made in Florence County at the junction of the Pine and Popple Rivers. The Florence iron mine was located in 1873, and the Commonwealth mine in 1876, and settlements grew up quite rapidly about these points. The city of Florence was laid out in 1880, and the county of that name was established from parts of Forest and Marinette Counties in 1884.

The southern part of the area and the portion bordering Green Bay were the first to be opened up, and as the timber was removed settlement gradually extended northward.

From the early settlement of this area many nationalities have been represented in the population. Probably half of the early settlers were native-born Americans from the southern part of Wisconsin and from other States. A large proportion of the foreign-born element was from Canada, of English and French extraction. The most im-

portant sources of immigration from Europe before 1885 were Germany, Sweden, Norway, England, and Ireland. Later the Poles became an important element. Bohemia, Austria, France, Denmark, and Holland were also represented. The greater part of the present population consists of native-born Americans. Native-born Germans are probably second, and Scandinavians third. One of the most extensive German settlements, and one which has a very highly-developed agriculture, is located in southeastern Shawano County, with Bonduel as its center. People of German descent predominate in Shawano County. In the extreme southeastern corner of this county, and in the extreme southern part of Oconto County, in the vicinity of Pulaski, Krakow, Zachow, Little Suamico, and Sobieski, the Poles are by far the most numerous. Settlements of the different nationalities are often grouped, and extensive communities are thus developed in time. Such communities are now found in the older portions of the area, and others are gradually being formed in the newly developed sections.

According to the census, the population of the entire area in 1910 was 118,578, or an average of about 19 per square mile. The southern and southeastern sections are well settled, and many communities have as dense a population as the highly developed farming districts of southern Wisconsin, while in Forest and Florence Counties, northern Oconto, northern and northwestern Marinette, and eastern and northern Langlade County there are extensive tracts of forested and cut-over land unoccupied. Forest and Florence Counties have an average of about 6 inhabitants to the square mile.

Florence, the county seat of Florence County, has a population of 1,838, and with Commonwealth forms the center of an important iron-mining district.

Crandon, the county seat of Forest County, has a population of 1,833, and is the center of a very promising agricultural region. Lumbering is still important and the city has a large sawmill, a lath factory, an excelsior factory, and a hub and handle factory. North Crandon, Laona, and Wabeno are other growing towns in Forest County.

Antigo is the county seat of Langlade County, and has a population of 7,196. It is a division point on the Chicago & North Western Railway, is the largest town in the county, and the center of a highly developed farming community where dairying is the leading industry. Elcho, Bryant, Polar, Phlox, Deerbrook, and Summit Lake are other towns within Langlade County.

Shawano, with a population of 2,923, is the county seat and largest town of Shawano County. Power is here developed from the Wolf River for operating a large pulp mill. Mattoon, Aniwa, Eland, Tigerton, Wittenberg, Bonduel, Cecil, and Pulaski are smaller towns scattered through the county. Keshena is a town in the Menominee

Indian Reservation in Shawano County and the site of the Government school.

Oconto, with a population of 5,629, is the county seat of Oconto County, and is still an important sawmill town, its mills turning out about 60,000,000 feet of lumber yearly. In addition, there is a canning factory, a large creamery, and a pickle factory, indicating the importance of the community from an agricultural standpoint. Oconto is situated on the Oconto River about 2 miles from where it empties into Green Bay. Gillett, Stiles, Oconto Falls, Suring, Mountain, Pensaukee, Little Suamico, Sobieski, and Lena are among the smaller towns within Oconto County.

Marinette, with a population of 14,610, is the county seat of Marinette County and the largest city in the area surveyed. Lumbering is still the most important industry at this place, though it is the center of a thriving agricultural community. A successful county agricultural school, established in 1905, and maintained jointly by the State and the county, is located at Marinette. Peshigo, Wausaukee, Goodman, Pembine, and Crivitz are among the small towns of the county. A substation of the State experiment station was established at Crivitz (Ellis Junction) in 1909. This station is devoted chiefly to demonstration work with farm crops best adapted to sandy soils and the general management of sandy soils.

TRANSPORTATION.

Prior to the advent of the railroads outside communication was carried on chiefly by boats on Green Bay and the Great Lakes. The first railroad reached Marinette in 1871. In 1881 what is now the Chicago, Milwaukee & St. Paul Railway was completed. In 1882 a line to Antigo was completed. Excellent transportation facilities are now afforded nearly every part of the area that has been developed, and railroad lines lead into many of the undeveloped regions where lumbering is being carried on. Three lines of the Chicago & North Western cross the area from north to south. One extends north from Green Bay parallel with the shore, passing through Pensaukee, Oconto, and Marinette, and extending into the iron-mining region of upper Michigan. A second line runs north from Green Bay through Pulaski, Gillett, Suring, Mountain, Wabeno, and Long Lake, and at Saunders, Mich., joins a line which extends from Powers, Mich., through Florence, Wis., to Ashland, Wis. A third line passes through Tigerton, Eland, Aniwa, and Antigo, and north to Watersmeet, Mich.

Running nearly at right angles to these three lines are two other branches of the North Western. One extending from Green Bay through Shawano and Eland connects with the Omaha Railway, which is a part of the same system, and gives through service to Minneapolis and St. Paul, while the other line runs from Oconto

through Gillett, Cecil, and Shawano to Clintonville, Wis. All these lines give direct service to Milwaukee and Chicago. A main line of the Chicago, Milwaukee & St. Paul Railway from Chicago and Milwaukee crosses the area north and south, passing through Sobieski, Abrams, Stiles, Lena, Crivitz, Wausaukee, and Pembine, and has branch lines reaching Marinette and Oconto. The main line of the Soo Line from Minneapolis and St. Paul to Sault Ste. Marie, Mich., crosses the area east and west through North Crandon, Armstrong Creek, and Pembine. The Wisconsin & Michigan Railway runs north from Peshtigo and serves the eastern townships of Marinette County. The Wisconsin & Northern runs north from Shawano through the Menominee Indian Reservation to Van Ostrand in Langlade County, with a branch extending to Phlox. Another line of this same road runs from Crandon to North Crandon. A line connecting these two spans has been surveyed. In addition to these lines there are a number of temporary logging roads which carry freight and passengers.

From the southern boundary of the area to Green Bay City the distance is but 12 miles. Milwaukee is 126 miles distant, and Chicago 211 miles. The Military Road from Green Bay northward through the area to Fort Wilkins, in Kewaunee County, Mich., on Lake Superior, was started about 1866 and completed through the area in 1870. This road passes through Pulaski, Bonduel, Shawano, Keshena, Keshena Falls, through the Menominee Indian Reservation along the Wolf River, and through eastern Langlade County into Forest County, where it passes through Crandon and Hiles. A few miles northwest of Hiles the road leaves the area surveyed, but continues northward through Oneida and Vilas Counties and the Upper Peninsula of Michigan. Some sections of this road have been abandoned, but the greater part of it is still a main highway and well improved.

PUBLIC ROADS.

Throughout the southern and southeastern sections of the area, which are well developed, there are public roads on most of the section lines, and many of these are graded, some being crowned with gravel and well improved. In the northern part of the survey, which is sparsely settled, there are few public roads. The wagon roads between the chief towns are usually in fair condition, but the side roads are generally poor. A number of roads are being improved under a new State highway law, through cooperation between the State and the county and township. All such roads are constructed under State supervision, according to approved scientific methods. All the counties in the area are making road improvements under this act and considerable progress has been made. It is planned to have a complete network of roads of this character throughout the State.

Rural delivery mail routes have been established in nearly all parts of the present survey. The rural telephone is in common use.

The rural schools in northeastern Wisconsin are equal to those of any other part of the State. Often where the attendance is small several districts are consolidated, and the pupils are carried to and from school in public conveyances maintained by the consolidated districts.

MARKETS.

The cities, towns, and lumbering camps within the area surveyed afford good markets for a large quantity of farm products, while all classes of produce find ready sale in the large cities, such as Green Bay, Milwaukee, and Chicago. The extensive lumbering activities in northern Wisconsin and Michigan, together with the iron and copper mining industries, create a demand for food supplies at good prices, Chicago quotations being paid f. o. b. the shipping points.

CLIMATE.¹

Among the factors which influence the agriculture of a State none is more important than climate. The class of crops which can be grown is largely determined by the length of the growing season and the amount and distribution of the rainfall. Any one of these factors may determine the type of agriculture which can be practiced to best advantage.

PRECIPITATION.

The distribution of rainfall over Wisconsin is remarkably uniform, the average yearly precipitation ranging from 28 to 34 inches. This is a slightly heavier rainfall than is received by eastern England, northern France, most of Germany, Sweden, and the Danube Valley. As compared with other portions of this country, Wisconsin has a rainfall equaling that of central Oklahoma and Kansas, northern Iowa, Michigan, northwestern New York, or the Puget Sound Basin of Washington. But owing to its northerly location the lessened evaporation probably makes the precipitation as effective as that of Arkansas, Illinois, or Virginia.

The local distribution of rainfall varies, however, from year to year, in different sections. The variation is caused by the movement of cyclonic storms. The average rainfall for the entire State during the driest year was 21.4 inches and for the wettest year 37 inches.

Of equal importance in agriculture to the total rainfall is its seasonal distribution, and in this respect Wisconsin is unusually fortunate, since about half of the total rainfall occurs in May, June, July, and August, and nearly 70 per cent from April to September, inclusive. The State receives during this growing season, April to Sep-

¹ This section is based upon Bulletin 223 of the University of Wisconsin Agricultural Experiment Station, entitled *The Climate of Wisconsin and its Relation to Agriculture*.

tember, inclusive, on an average 21 inches of precipitation, as much as falls during the same months in eastern Texas, Illinois, Ohio, or eastern New York. June has the heaviest rainfall, averaging 4.1 inches, while July averages 4 inches and May 3.9 inches. The precipitation during the winter, on the other hand, is slight, December, January, and February each averaging from 1 to 1.5 inches of rain and melted snow. The small winter precipitation in Wisconsin, mainly in the form of snow, causes virtually no erosion, or leaching of fertility from the soil. The average rainfall for the State during the winter is 3.9 inches, during the spring 8.3 inches, during the summer 11.4 inches, and during the autumn 7.4 inches.

Another phase of rainfall distribution of great importance is its regularity. Frequently periods of drought or of unusually heavy rainfall occur, continuing for 1 week to 4 weeks, or even longer. Observations made at Madison by the Weather Bureau over a period of 30 years, from 1882 to 1911, inclusive, show that there are on the average three 10-day periods during each growing season when crops on a moderately heavy soil actually suffer from lack of moisture. A similar condition prevails in the area surveyed, and is even more marked on the light-textured soils.

The following table gives the mean precipitation at five points within the survey and also at Menominee, Mich., which is just across the Menominee River from Marinette, Wis.:

Mean monthly, seasonal, and annual precipitation.

	Florence.	Crandon.	Oconto.	Shawano.	Koepenick.	Menominee, Mich.
	<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>	<i>Inches.</i>
December.....	1.54	1.11	1.80	1.52	1.26	0.94
January.....	1.08	1.38	1.64	1.32	1.35	1.11
February.....	1.39	1.25	1.56	1.15	1.28	1.09
Winter.....	4.01	3.74	5.00	3.99	3.89	3.14
March.....	2.05	1.52	2.15	1.69	1.86	1.71
April.....	2.44	2.09	2.59	2.77	2.71	1.75
May.....	3.76	2.40	3.60	2.97	3.62	3.25
Spring.....	8.25	6.01	8.34	7.43	8.19	6.71
June.....	3.53	2.66	3.40	3.16	3.96	3.31
July.....	4.10	3.55	3.32	3.46	3.84	3.94
August.....	3.20	2.60	2.50	2.26	3.41	2.52
Summer.....	10.83	8.81	9.22	8.88	11.21	9.77
September.....	3.27	3.56	3.00	2.88	4.21	3.43
October.....	2.60	2.37	2.24	2.41	3.17	2.22
November.....	2.11	2.05	2.07	1.61	1.98	1.44
Fall.....	7.98	7.98	7.31	6.90	9.36	7.09
Year.....	31.07	26.54	29.87	27.20	32.65	26.71

It will be seen from the above table that the mean annual precipitation of the area surveyed is 29 inches, and that the greater part of this occurs during the growing season, when most needed. It will be noted that for the months from May to September, inclusive, there is an average monthly rainfall of at least $2\frac{1}{4}$ inches recorded at every station and that in most cases it exceeds 3 inches. Periods of light rainfall, however, also are apparent.

LENGTH OF GROWING SEASON.

A large part of the area surveyed lies within the Northern Highland, which is recognized as one of the eight climatic provinces of

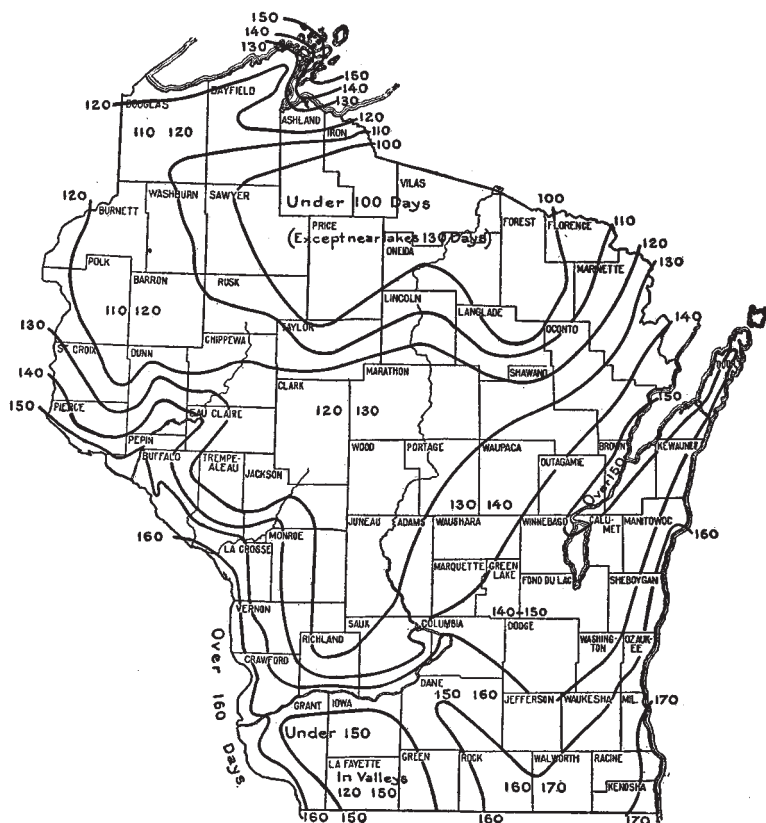


FIG. 42.—Sketch showing length of growing season in the area surveyed as compared with other parts of Wisconsin.

Wisconsin. The portion of this region within the area has an elevation ranging from slightly above the Great Lakes level to over 1,600 feet above sea. In this highland rise the Wolf and Eau Claire Rivers, tributaries of the Wisconsin River, and the courses of the Peshtigo, Oconto, Pine, and other large streams lie entirely in this region. The northern part of the area is characterized by a short growing

season, cold winters, and warm summer days with cool nights. In the extreme north the growing season is somewhat less than 100 days, but this gradually lengthens with distance south and east, until in the southern and southeastern sections, bordering Green Bay, there is an average growing season of about 150 days. As far inland as Shawano the growing season is over 130 days. The climatic influence of Green Bay is practically confined to a belt 5 to 10 miles in width immediately bordering the bay. The southeastern half of the area surveyed has a growing season practically as long as that in the southwestern section of Wisconsin, including St. Croix, Pierce, Buffalo, Monroe, Richland, Iowa, and intervening counties. The portion of the area immediately bordering Green Bay has about the same length of growing season as Fond du Lac, Winnebago, Dodge, and Calumet Counties. Figure 42 shows the length of the growing season in the area surveyed, as compared with other parts of the State.

The following table gives the average dates of the last killing frosts in the spring and the first in the fall at various stations within the area and at Menominee, Mich.:

Average dates of killing frosts.

Station.	Length of record (years).	First killing frost in fall (average date).	Last killing frost in spring (average date).	Eleva- tion of station above sea level.
				<i>Feet.</i>
Florence.....	18	Sept. 13	June 2	1,293
Crandon.....	12	Sept. 14	June 3	1,060
Menominee, Mich.....	9	Oct. 6	May 16	581
Oconto.....	19	Oct. 2	May 10	590
Shawano.....	13	Sept. 26	May 14	796
Koepenick.....	18	Sept. 17	June 3	1,683

From this table it will be observed that the average date of the first killing frost in the fall at the different stations ranges from September 13 to October 6, and of the last killing frost in the spring from May 10 to June 3. In the extreme northwestern part of the area summer frosts may occur, but these are seldom so severe as seriously to injure growing crops. As the timber is cleared away, the land more thoroughly drained, and more of the land put under cultivation, the growing season gradually lengthens.

TEMPERATURE.

The table following gives the mean monthly, seasonal, and annual temperature as recorded at five stations within the area and at Menominee, Mich.

Mean monthly, seasonal, and annual temperature.

Month.	Florence.	Crandon.	Oconto.	Shawano.	Koepenick.	Menominee, Mich.
	° F.	° F.	° F.	° F.	° F.	° F.
December.....	18.2	16.6	22.6	21.5	18.1	23.2
January.....	13.4	11.6	17.1	17.3	12.7	18.1
February.....	12.8	16.1	17.6	17.4	13.9	14.6
Winter.....	14.8	14.8	18.9	18.7	14.9	18.6
March.....	23.9	25.9	29.2	27.1	26.0	28.2
April.....	38.9	41.0	43.1	42.8	41.7	39.7
May.....	51.0	52.5	54.1	53.8	54.5	50.4
Spring.....	37.9	39.8	42.1	41.2	40.7	39.4
June.....	61.8	63.3	64.4	64.9	64.5	61.7
July.....	65.6	66.8	69.0	68.9	67.4	68.0
August.....	63.4	63.6	67.3	66.9	64.3	66.8
Summer.....	63.6	64.5	66.9	66.9	65.4	65.5
September.....	56.6	57.8	60.8	59.4	58.9	59.6
October.....	44.2	44.7	48.5	47.6	45.8	49.5
November.....	29.9	28.8	34.3	31.8	31.4	35.8
Fall.....	43.6	43.8	47.8	46.3	45.3	48.3
Year.....	40.0	40.7	44.0	43.3	41.6	43.0

It will be seen from this table that the mean summer temperature at the different stations ranges from 63.6° F. to 66.9° F., and that the mean annual temperature for all the stations is 42.1° F. There are only about 5 days during the summer when the temperature rises above 90°, and it seldom reaches 100°. There is also an average of about 5 winter days when it falls lower than 20° below zero.

While the winters are long and severe, the summers are mild, and all crops make a rapid growth. The enjoyable summer climate, the excellent fishing, the abundant supply of good water, the numerous summer resorts on the lakes, and the hunting all combine to attract tourists to this region in large numbers. These factors have encouraged settlement of large areas of unimproved agricultural land.

AGRICULTURE.

EARLY HISTORY AND PRESENT CONDITIONS.

The most reliable records available indicate that the first farm to be cleared and put under cultivation within the present survey was started by John G. Kittson, a clerk of the American Fur Co., who began farming operations on a small scale at his trading post at Wausaukee Bend on the Menominee River in 1825. Between 1829 and 1850 lumbering operations were started in the southern part of

Marinette, Oconto, and Shawano Counties, and around each sawmill settlement a farming community gradually developed to supply the wants of the settlers and mill workers. The first farms consisted of garden plots and hay meadows among the stumps, and the quantity of produce from any one farm was small. Many of the early settlers who took up farming were obliged to cut the timber and burn the logs, as the hardwood was of little value and nothing but the pine was handled by the mills. It was a common practice in the early days, and it is still customary in the less developed sections, for the men with families to work in the logging camps and mills during the winter months and cultivate their fields during the summer. The methods originally followed were crude, but the virgin soil was very productive, and large yields were often secured with but little attention to selection of seed or cultivation. While there were a number of small rural settlements scattered throughout the southern part of the area before the close of the Civil War, agricultural operations were not well under way until the seventies, and farming could not be considered of very much importance until the early eighties. By this time large tracts had been cleared in southern Marinette, Oconto, and southeastern Shawano Counties, and substantial farming communities were established. The first homestead in Langlade County was taken up in 1875, and a settlement was made at Phlox in 1876-77. Lumbering operations were extensively carried on in the immediate vicinity of Antigo during the eighties and nineties, and homesteaders followed close on the steps of the lumbermen.

Extensive and highly improved farming communities are now to be found in eastern and southern Langlade, southern and southeastern Shawano, southern and southeastern Oconto, and southern Marinette Counties. Between this condition and the extensive tracts of virgin forest and undeveloped cut-over lands throughout the northern part of the area surveyed all stages of agricultural development are apparent. Practically all the extensive farming activity is carried on south of a line extending from Wausaukee in Marinette County to Breed in Oconto County, thence around to the south of the Menominee Indian Reservation, and thence northward through Bryant and Deerbrook, to Parrish in Langlade County. North of this line in the vicinity of Elcho, Crandon, North Crandon, Wabeno, and Mountain farming communities are rapidly being developed. Florence County also contains a few thriving farming settlements.

The crops grown most extensively by the early settlers were hay, oats, potatoes, and other root crops. Oats and hay early became the most important sources of income, as the lumbermen required large quantities of feed for their stock. Wheat was an important crop in the older communities for a number of years. The small

grains have never attained the importance in this region, however, that they held in older portions of the State, chiefly because the oldest agricultural communities here were just well established when grain growing elsewhere was at its height. With the decline in grain production more general farming was practiced, and dairying gradually came to occupy an important place. Hay was often cut 5 to 10 years on the same field until yields were no longer profitable, and then the field was plowed for other crops. Little thought was given to crop rotation in the early days.

PRINCIPAL CROPS GROWN.

At the present time the type of agriculture most extensively practiced consists of general farming in conjunction with dairying, with hay and oats as the most important money crops. This type of farming is being followed on practically all cleared portions of the area surveyed, and the older the community the higher has it been developed. In the newly developed communities potatoes are the leading money crop.

The crops most extensively grown in the area are hay, oats, corn, barley, potatoes, rye, wheat, and peas. Hay is grown more extensively than any other crop. Over half of the hay grown consists of mixed clover and timothy, the remainder being made up of these crops grown alone, marsh hay, millet, grain cut for hay, some coarse forage, and, to a small extent, alfalfa and pea vines. When dry peas are thrashed the pea straw is frequently fed as hay, but its value is considerably less than where the vines are cut green and cured for hay. There is usually about five times as much timothy grown alone as clover alone. The average yield of hay for the entire area is about $1\frac{1}{2}$ tons per acre. On the light sandy soils the yields are usually low, while on the fine sandy loams and heavier soils very satisfactory yields are obtained. The heavier types of soil are well suited to all kinds of grasses and clovers common to the region, and throughout the unsettled cut-over country a luxuriant growth of grasses is seen along logging roads and trails. Yields of 2 to $2\frac{1}{2}$ tons of timothy and clover are very common on the best farming soils. Small quantities of clover seed are produced in various parts of the area. Alfalfa can be grown successfully in every county in the survey, and the acreage is gradually increasing. Where the soils are in an acid condition liming is necessary. Inoculation with nitrogen-gathering bacteria is also necessary. A considerable quantity of hay is sold from many of the farms each year to the logging camps in northern Wisconsin and Michigan at good prices.

Oats are grown more extensively than any other grain crop. In 1909 there were over 35,000 acres of oats in Shawano County, nearly 25,000 in Oconto County, over 13,000 in Marinette County, over 9,000

in Langlade County, and about 2,200 acres in Forest and Florence Counties together. The average yield in 1909 for all the soils used for oats was about 31 bushels per acre. The yields on the light sandy soils, which are poorly adapted to oats, are very low, but on the soils as heavy as a fine sandy loam or heavier, which are well adapted to oats, they are very satisfactory. Yields of 50 bushels per acre are common, and 70 or 80 bushels per acre are frequently produced. The crop is grown most extensively on the Kewaunee fine sandy loam, loam, and clay loam, the Merrimac silt loam, Gloucester silt loam and fine sandy loam, Spencer silt loam, Miami fine sandy loam, Superior fine sandy loam, and Fox fine sandy loam. Much of the oats is fed to stock on the farms, but on most farms the crop also is a source of cash income.

Although this area is all north of the city of Green Bay, in a province usually considered as being poorly adapted to corn, statistics show that corn is the third crop in acreage. In 1909 Shawano County had over 12,000 acres in corn, with a yield of over half a million bushels—slightly over 41 bushels per acre of mature corn. In the same year Oconto County had about 7,500 acres in corn, Marinette County over 3,500 acres, and Langlade County about 600 acres. In addition to these acreages there was a large quantity of corn grown for fodder or for ensilage. As dairying develops the number of silos increases correspondingly, and this calls for an enlarged acreage of corn harvested before maturity. Golden Glow, Silvery King, and Wisconsin No. 8 are early dent varieties that are successfully grown in addition to the native yellow dent corn of mixed breeding. Flint corn is also quite common, but the acreage seems to be decreasing with the advent of the silo. It may safely be said that throughout the southern part of the area surveyed the dent varieties mentioned above mature four years out of five. After being acclimated for three or four seasons the dent corn will mature nearly as early as the flint corn. Corn is grown most extensively on the Kewaunee fine sandy loam, Miami fine sandy loam, Gloucester silt loam, Spencer silt loam, and Merrimac silt loam, although it is planted on practically all the soils of the area. The heaviest soils of the area, such as the Kewaunee loam and clay loam, and the level, rather poorly drained phases of the Merrimac silt loam and Spencer silt loam, are rather "cold" and "late," and are not so well adapted to corn as the types having a sandy or fine sandy loam surface soil and a subsoil which is sufficiently porous to allow good internal drainage, but not so light as to allow the soil to suffer from drought. The Kewaunee fine sandy loam, Miami fine sandy loam, Gloucester silt loam, Merrimac silt loam, and Spencer silt loam are the extensive types best adapted to corn growing in the present survey. Yields on these types range from 30 to about 60 bushels per acre, with an aver-

age of about 45 bushels. On the lighter soils the yields range from 15 to 35 bushels. More care is being exercised each year in the selection of seed corn, and this, with improved methods of culture, is gradually increasing the yield per acre, as well as improving the quality of the corn.

Barley is the second small-grain crop of importance, though the acreage of rye is almost as large. Barley is grown most extensively in Shawano, Oconto, and Langlade Counties, and in 1909 the total acreage in these three counties was over 15,000 acres, and the average yield per acre slightly over 25 bushels. The yields on the light soils are low, but on the Merrimac silt loam, Kewaunee fine sandy loam, and Miami fine sandy loam yields of 35 bushels per acre are quite common. While some of the barley is fed to stock on the farms, the greater part of it is sold to local breweries. As a rule, a very satisfactory price is obtained. Barley is produced mainly on the Merrimac silt loam, Kewaunee fine sandy loam, and Miami fine sandy loam.

Rye is grown to some extent in all the counties surveyed. On account of its early maturity and its peculiar ability to withstand drought it is recognized as a good crop for light soils. In 1909 Shawano County had 6,667 acres in rye, Oconto County 4,566, Marinette County 2,478, Langlade County 630, and Florence and Forest Counties each less than 100 acres. The average yield on the entire range of soils was about 15 bushels per acre. In Langlade County rye is grown more extensively on heavy soils than on sandy soils, and the yields obtained are above the average. In this county, though the acreage is small, the crop is grown chiefly on the Merrimac silt loam and Spencer silt loam and the average yield is slightly over 20 bushels per acre.

Wheat is grown to a very small extent and is practically confined to Shawano, Oconto, and Marinette Counties. In 1909 these three counties had a total of about 7,000 acres in this crop, with an average yield of about 15 bushels per acre. Grain of good quality is produced, but the crop is not gaining in favor; in fact, the acreage is being reduced. It would seem, however, that there should still be a place in the crop rotation for wheat, and that with proper methods of cultivation and seed selection the crop should be profitable.

Over portions of the area potatoes and peas may be classed with the general farm crops, though they are usually considered as special crops. Potatoes are largely depended upon for quick money returns, especially by the new settlers. No one soil is devoted primarily to their culture and they are grown on practically all of the soil types mapped, both for home consumption and on a commercial scale. In the southern part of the area, where dairying is well developed, potatoes are grown mainly on the lighter soils, but in the northern

and newer agricultural sections they are grown on all types of soil, for in that region they are an important source of cash income. In Forest County, at Crandon, North Crandon, and Wabeno, potatoes are grown most extensively on the Gloucester silt loam and Merrimac silt loam. In Langlade County they are grown on the Merrimac silt loam and Gloucester silt loam and sandy loam. In the vicinity of Mountain, in Oconto County, and at a number of other places in the area the crop is grown largely on fine sandy loam and to some extent on fine sand. In 1909 there were over half a million bushels produced in Shawano County and nearly that many in Marinette County. Oconto County produced over a quarter million bushels the same year and Langlade County about 180,000 bushels. The acreage devoted to potatoes is increasing and potato warehouses are being constructed in many of the newly developed communities. The average yield for the whole area in 1909 was 125 bushels per acre. Yields much higher than this are obtained, however, with careful management. Yields of 200 to 250 bushels per acre are not uncommon for fields of 10 or 12 acres. As a rule, the varieties grown are mixed, but potato growers' associations are now being formed and efforts made to have farmers cooperate in growing fewer varieties, of recognized merit, so as to be able to place upon the market potatoes of uniform size and quality. The Early Ohio, Triumph, Hebron, Early Rose, Rural New Yorker, and Burbank are among the varieties now grown.

Peas are grown both for seed and for canning purposes. In 1909 there were over 13,000 acres of peas matured in the area, in addition to a large acreage for canning. Canning factories are located at Oconto, Oconto Falls, and Antigo, and most of the peas for canning are grown within a radius of about 5 miles of these places. A common method followed is for the canning factory to rent the land from the farmers, paying about \$8 per acre and doing all the work of cultivation and harvesting. Frequently the farmers plow the land and receive a rental of \$10 per acre. Peas intended for canning are sowed at intervals, so that successive crops may be gathered when the peas are in the best condition for canning. When the crop is allowed to mature yields of about 10 to 30 bushels of dry peas per acre are obtained, with an average of about 15 to 20 bushels. Peas of the best quality are grown on the Merrimac silt loam, Kewaunee fine sandy loam, and Miami fine sandy loam, and most of the crop is produced on these soils.

Buckwheat is grown to a small extent in different parts of the area, chiefly on the light-textured soils. Yields usually run from 15 to 18 bushels per acre.

While beans can be grown successfully and profitably on many of the soils of the area, the acreage devoted to this crop is small. They

are grown chiefly on the sandy soils. The White Navy is the variety most common.

The following table, compiled from the Thirteenth Census, gives the acreage and production in 1909 of various general farm crops in each of the six counties included in this survey:

Approximate acreage and production of crops by counties.

	Florence.	Forest.	Langlade.	Marinette.	Oconto.	Shawano.
Approximate land area in square miles.....	497	1,400	875	1,415	1,118	1,158
Percentage of land under cultivation.....	2.6	.68	8.5	8.7	18.7	22.9
Hay and forage:						
Acres.....	3,468	2,239	18,891	23,690	42,034	41,378
Production (tons).....	3,089	2,830	27,807	31,988	60,019	63,206
Corn:						
Acres.....	64	55	602	3,597	7,441	12,575
Production (bushels).....	1,824	968	24,367	94,913	239,113	500,719
Oats:						
Acres.....	1,612	617	9,554	13,029	24,975	35,010
Production (bushels).....	45,053	22,010	325,550	405,503	752,296	1,049,130
Barley:						
Acres.....	195	66	2,597	1,499	4,016	9,139
Production (bushels).....	4,241	1,702	70,481	32,019	83,543	227,886
Potatoes:						
Acres.....	379	483	1,329	3,689	3,099	4,061
Production (bushels).....	57,898	62,998	180,970	439,858	304,004	506,125
Wheat:						
Acres.....	54	10	193	893	2,028	4,171
Production (bushels).....	872	182	3,382	15,669	30,907	73,554
Rye:						
Acres.....	51	15	630	2,478	4,566	6,667
Production (bushels).....	980	242	12,669	43,989	68,274	99,927
Peas (dry):						
Acres.....	20	23	1,459	2,900	5,640	3,452
Production (bushels).....	369	340	27,331	44,212	82,231	48,711

SPECIAL CROPS.

There are a few special crops and some truck crops grown within the area, though no one line of intensive agriculture has become highly developed in this part of Wisconsin. Sugar beets are grown successfully, though on a small scale. They are confined to the southern portion of the area, in Marinette, Oconto, and Shawano Counties. The yields range from 6 to 18 tons per acre, with an average on the soils best adapted to the crop of 11 to 12 tons per acre. Beets produced in this region have a higher sugar content than those grown in the southern part of the State. Practically all of the beets grown in the area are shipped to Menominee, Mich., where there is a beet-sugar factory. The price received is about \$6 per ton.

Ginseng is quite extensively grown in Langlade County, and a few gardens are also found in the other counties of the survey. Langlade County produces more ginseng than any other county in the United States. The value of the crop sold in the fall of 1913 was estimated at about \$200,000. Gardens range from a few square rods to about 3 acres in extent. All gardens are artificially shaded, and great care and patience are necessary in growing this crop. The salable products from this plant are the dried roots, dry seed, and germinated seed, though the dry roots constitute the main product. Most of the roots are sold to local merchants, who ship to New York, whence the product is shipped to China. There are a number of diseases which attack the plants, but by following proper methods of cultivation and spraying these can be largely controlled. The dried roots bring from \$4 to \$7 per pound on the local market, and an acre of good healthy ginseng, well established, is worth about \$15,000 to \$20,000. It requires 18 months for the seed to germinate, and it is about 5 years from the time the seed is planted until the roots are large enough to be marketed. Most of the gardens are on the Merrimac silt loam and Gloucester silt loam.

TRUCK CROPS.

The trucking industry is not extensively developed in any part of the area, though in the vicinity of the larger towns there are small tracts devoted to special crops. Strawberries are probably grown more extensively than any of the other truck crops, and very satisfactory results are obtained. Yields range from 1,000 to 1,500 quarts per acre, and there is always a ready market, at a good price. The local towns and the mining camps of northern Michigan take all the strawberries that are offered for market. Strawberries of excellent quality are grown on a wide variety of soils, though the greater proportion is doubtless produced upon the fine sandy loam types. The soil and climatic conditions and the generally ample transportation facilities favor the extension of the acreage devoted to this and other truck crops.

Cucumbers are grown in several localities, especially on the sandy soils. A number of pickle factories and salting stations are located within the area, and they usually contract for the entire crop. A farmer seldom grows more than an acre of cucumbers, since the crop requires considerable labor at a time when laborers are usually scarce. Cabbage, lettuce, tomatoes, celery, and a number of other garden crops are grown to a limited extent, chiefly for home use.

FRUITS.

Orcharding is carried on in the area to a small extent, chiefly in the southern and southeastern sections and mainly on the Kewaunee

and Miami fine sandy loams. Throughout the region covered by these types nearly every farmer has a small apple orchard, and there are over 125,000 apple trees, which yield on the average a little over one bushel of fruit each. The greater proportion of the trees receive little, if any, attention. Among the varieties most extensively grown are the Wealthy, Duchess, Northwestern Greening, Red Astrachan, Grimes, Wolf River, Northern Spy, Early Harvest, Snow, and a number of varieties of crab apples. There are a large number of good orchard sites and the success which has been attained without careful attention indicates that fruit growing could be profitably extended under intelligent management, and commercial orcharding established on a much larger scale than at present.

Cherries, plums, pears, and grapes are grown to a very small extent, but sufficient to indicate that they can be produced successfully, at least for home use. On the lowlands along Green Bay it would seem that these fruits, especially cherries, might be successfully grown on a commercial scale.

The profusion in which raspberries and blackberries grow wild throughout the newly developed portions of the area indicates that bush berries could be grown commercially. At present the supply of wild berries is ample for the developing communities, but these do not stand shipping as well as improved varieties. Raspberries, blackberries, currants, and gooseberries are grown under cultivation in the older settlements for home consumption, and frequently a small quantity is placed on the local market. Blueberries grow wild in a number of localities, and large quantities are gathered and sold by the Indians.

At Stiles large greenhouses have been erected recently for the growing of mushrooms and winter-grown vegetables. Where shipping facilities are ample, as they are at this point, extension of this industry would doubtless be profitable, as wood for fuel is cheap. In large cities the cost of fuel is one of the most important items in the greenhouse business.

The following table, compiled from the Thirteenth Census, gives the quantities of orchard and small fruits grown in 1909 in each of the counties surveyed:

Orchard and small fruit products.

	Florence.	Forest.	Langlade.	Marinette.	Oconto.	Shawano.
Apples:						
Trees.....	2,025	153	2,823	26,073	43,221	42,863
Bushels.....	2,333	83	3,269	26,005	48,072	48,897
Plums and prunes:						
Trees.....	31	5	478	207	783	630
Bushels.....			46	15	60	95

Orchard and small fruit products—Continued.

	Florence.	Forest.	Langlade.	Marinette.	Oconto.	Shawano.
Cherries:						
Trees.....	61	1	62	941	2,791	4,013
Bushels.....	7		4	252	821	1,475
Grapes:						
Vines.....	1		2	45	282	142
Pounds.....			50	470	2,318	1,016
Strawberries:						
Acres.....	1—	2	10	25	19	10
Quarts.....	180	2,435	13,297	43,686	28,602	13,204

DAIRYING.

Dairying is the most important branch of agriculture followed at the present time in northeastern Wisconsin, and the one which gives the greatest promise of extensive growth as the country develops. As yet purebred dairy cattle are not at all plentiful. Pure-bred sires, however, are used in building up the herds, and frequently are purchased jointly by several farmers for the improvement of a number of herds. Holstein and Guernsey seem to be the dairy breeds most in favor, and there are at present more grade Holsteins than any other breed. A reason for this doubtless lies in the fact that a large proportion of the dairy products is marketed in the form of cheese, and the Holstein produces a large quantity of milk. Furthermore, when it is desired to turn off any of the stock for beef the Holstein brings larger returns than other dairy breeds. In 1910 the value of the dairy products for the whole area amounted to \$1,624,000, and at present it is doubtless over \$2,000,000 annually. Most of the dairy output is sold as cheese and butter. In 1913 there were 41 creameries and 116 cheese factories within the area. Cheese factories are increasing more rapidly than creameries. Some milk and cream is shipped to cities outside the area, but in small quantity compared with that made into butter and cheese.

As the country becomes more settled dairying is extending farther northward. The development of dairying has resulted in the introduction of silos, as the farmers realize the desirability of silage for dairy stock.

The table following, compiled from the 1910 census and from the Wisconsin Dairy and Food Report for 1910, gives the number of dairy cows in the various counties of the area and the number and distribution of cheese factories and creameries.

Status of dairy industries.

	Florence.	Forest.	Langlade.	Marinette.	Oconto.	Shawano.
Number of dairy cows.....	709	565	7,215	8,335	15,709	24,093
Milk produced, gallons.....	189,068	146,716	1,339,382	1,806,906	4,016,487	8,728,344
Creameries:						
1910.....			6	2	12	18
1913.....		1	7	5	12	16
Cheese factories:						
1910.....			9	7	23	62
1913.....			10	5	33	68
Value of dairy products, excluding home use of milk and cream.....	\$20,480	\$19,331	\$199,361	\$235,987	\$410,650	\$738,188

STOCK RAISING.

The raising of beef cattle has not reached any extensive proportions in this part of Wisconsin, although on many farms some stock is fattened for market. Some of the lumbering companies, as well as individuals owning large tracts of cut-over land, buy up young cattle in the spring, graze them through the summer, and sell them in the fall either as feeders or as grass-finished cattle. Excellent pasturage is afforded throughout the cut-over regions, especially on the heavier types of soil, and in addition to the profits derived from fattening the cattle their grazing assists in the clearing of the land, which is a very important matter. Beef cattle can be kept over winter with profit, and with the more extensive growing of alfalfa beef cattle can be profitably fattened in all the counties.

Horses are not extensively raised for market, but many farmers raise their own work stock. Heavy horses bring high prices at the logging camps.

In the older portions of the survey hogs are raised, chiefly in conjunction with dairying, but the number is not so great as in sections of the State where corn is more extensively grown. The Poland China, Berkshire, and Duroc Jersey are the most popular breeds.

Sheep are raised in smaller numbers than hogs. The flocks might be increased to advantage since sheep can be easily carried over the winter, and are of assistance in clearing land.

Some poultry is kept on practically all the farms, and the products sold figure materially in gross receipts from the farms. A few farmers keep bees, and some place small quantities of honey on the market each year.

The following table, compiled from the 1910 census, gives a fair idea of the distribution and value of the live stock, poultry, and bees:

Distribution and value of live stock.

	Florence.	Forest.	Langlade.	Marinette.	Oconto.	Shawano.
Cattle:						
Number.....	1,347	1,072	13,382	15,678	28,952	46,192
Value.....	\$30,753	\$28,666	\$293,689	\$309,918	\$574,911	\$898,275
Horses:						
Number.....	500	406	3,054	4,419	7,243	9,307
Value.....	\$65,805	\$48,682	\$394,605	\$461,527	\$807,549	\$1,103,109
Hogs:						
Number.....	184	306	3,874	7,917	12,577	32,920
Value.....	\$2,104	\$3,727	\$31,913	\$50,804	\$82,993	\$205,699
Sheep:						
Number.....	942	25	2,736	3,569	4,662	17,807
Value.....	\$4,044	\$130	\$9,088	\$12,152	\$14,008	\$53,316
Poultry, all kinds:						
Number.....	5,960	5,521	39,010	56,518	91,276	141,696
Value.....	\$3,078	\$3,040	\$19,857	\$25,556	\$36,806	\$56,217
Colonies of bees:						
Number.....	4		293	334	691	1,479
Value.....	\$24		\$1,521	\$1,261	\$2,435	\$6,800

ADAPTATION OF SOILS TO CROPS.

The question of the adaptation of soils to crops has not been given as much consideration in this region as in older sections of the country. It is generally recognized, however, that certain soils favor a certain crop or class of crops, as, for instance, that rye will do better on sandy soils than any other small grain. Greater success is possible in dairying on the fine sandy loams and silt loams than on the light sandy soils. Potatoes, beans, and buckwheat give good results on the sandy types.

ROTATION OF CROPS.

Various crop rotations are practiced within the area, but little careful study has been given to the selection of rotations best adapted to the individual types of soil. Many instances were observed where fields have been allowed to remain in grass, cut for hay, for 5 to 8 years. In other cases small grains have been grown for years upon the same field without the introduction of any legumes or intertilled crops. In the southern part of the area, on the silt loam and fine sandy loam soils, where considerable corn is produced, a rotation quite commonly followed consists of corn for 1 year, followed by oats or barley seeded to timothy and clover. Hay may be cut for 1 or 2 years and the field then pastured for a year or two, after which it is again plowed for corn. On the sandy soils a common rotation consists of rye for 1 year, followed by clover, and this crop by potatoes, corn, or beans. Buckwheat may then be grown for 1 year.

MANURES.

Barnyard manure is the only fertilizer extensively used, but the supply is never sufficient to cover the cultivated portions of any of the farms more often than once in 6 or 8 years. The logging camps accumulate large quantities of manure, but this is often so full of weed seeds that many farmers hesitate to apply it to their fields. Green manuring is not practiced to any extent, though there are a few farmers who frequently plow under a crop of clover or rye.

WEEDS.

The most important weed pests within the area are the Canada thistle and quack grass. The use of imported feed in the lumber camps is largely held responsible for the introduction of these weeds. In a number of places they are so abundant as materially to reduce yields in the fields they infest. Wild mustard is abundant in places.

FARM IMPROVEMENTS.

In the older and more thickly settled portions of the area the farms are, as a rule, well improved. Stone-basement barns are common, the houses are well built, and the farm buildings are usually kept painted and in good repair. Even in the newly developed districts many substantial farm buildings are to be seen. The temporary home of the settler soon gives way to a good house and outbuildings.

The labor problem is not nearly so serious in this region as in older portions of the State. Many of the men who work in the lumber camps during the winter take up farm work during the summer. On many of the farms the family is sufficiently large to handle all the work without extra help. Women work in the fields to a considerable extent, especially in the Polish, Dutch, and German settlements. Extra labor is often needed only at times of haying and harvesting.

In the opening up of new farms in this region the clearing of the land is the first operation. In some sections covered by this survey stones are plentiful and their removal sometimes is as expensive as clearing of timber. This, however, is unusual. Usually a site is selected which seems best suited for the location of the farm buildings and clearing goes on from this center. All brush, logs, and stumps may be removed from a small tract for cultivated crops, and a larger area simply cleared of brush and logs sufficiently to be seeded and pastured. The stumps can then be gradually removed, or cultivated crops grown between. After a few years the hardwood stumps will decay and can be readily pulled or burned out. Stump-pulling machines, dynamite, and fire are used in removing the stumps. In many places fires have run through the cut-over country and cleared away most of the underbrush and old logs, so that the cost of preparing the land for the plow is greatly reduced.

As indicated by the census of 1910, in Shawano County 51.4 per cent of the land area is in farms, in Oconto County 39.8 per cent, in Marinette County 24.2 per cent, in Langlade County 23 per cent, in Florence County 9.2 per cent, and in Forest County 3.1 per cent. In Shawano County 44.7 per cent, and in Forest County 21.7 per cent of the land in farms is improved. The proportion of improved land in the other counties ranges between these extremes. The average size of farms ranges from 90 acres in Langlade to 119 acres in Forest County. In Shawano County the average size of the farms is 107 acres, and the average acreage of improved land on each farm is 48 acres. Over 93 per cent of the farms in the area are worked by the owners.

LAND VALUES.

The average value of farm land ranges from about \$16 an acre in Florence County to \$35.05 in Shawano County. The increase in value during the decade from 1900 to 1910 was approximately 100 per cent. The value of land improved and unimproved is variable, depending upon the character of the soil, topography, location, improvements, and merchantable timber. Some of the lightest sandy soils can be bought for \$4 an acre. The best grade of cut-over land frequently brings \$20 to \$25 an acre, and most of the wild land without timber has a value between these limits. Good hardwood-timber land has a selling value of \$20 to \$50 an acre, depending upon its location, the condition of the timber, and the ease with which it can be gotten out. In the regions where farming is well developed, as in the southern part of the area, land values are quite high. In the vicinity of Bon-duel farms frequently sell for \$100 an acre. In the vicinity of Antigo improved farms several miles from town sell for \$40 to \$75 an acre, and those nearer for a correspondingly higher price. In the vicinity of Gillett and throughout southeastern Oconto County improved farms on good soil sell for \$50 to \$100 an acre, depending upon the location, improvements, and soil.

The following table, compiled from the 1910 census, shows the conditions as to size, state of improvement, value, and tenure of farms in the six counties of the northeastern Wisconsin area:

Size, improvement, value, and tenure of farms.

	Florence.	Forest.	Langlade.	Marinette.	Oconto.	Shawano.
Approximate land area, acres.....	318,080	896,000	560,000	905,600	715,520	741,120
Per cent of land area in farms.....	9.2	3.1	23.0	24.2	39.8	51.4
Number of all farms.....	274	237	1,434	1,919	2,868	3,549
Average size of farms, acres.....	106	119	90	114	99	107
Per cent of farm land improved.....	29.1	21.7	37.1	36.2	47.0	44.7
Average improved land per farm, acres.....	31	26	33	41	47	48

Size, improvement, value, and tenure of farms—Continued.

	Florence.	Forest.	Langlade.	Marinette.	Oconto.	Shawano.
Improved land in farms, 1910, acres..	8,491	6,129	47,788	79,474	133,961	170,218
Improved land in farms, 1900, acres..	4,312	1,573	31,168	47,126	91,273	135,322
Average value per acre of farm property, 1910.....	\$16.00	\$21.08	\$31.69	\$23.67	\$31.40	\$35.05
Average value per acre in 1900.....	\$8.45	\$10.72	\$13.55	\$13.33	\$16.55	\$17.27
Per cent of farms operated by owners.	93.4	92.8	92.0	93.9	94.6	95.4

SOILS.

The region covered by the present survey, in common with all of northern and eastern Wisconsin, owes the general character of its surface to glacial action. Two distinct periods of glaciation are represented in this region. The older drift is confined to the southwestern part of Langlade County and is the continuation of an extensive area in Marathon, Clark, Wood, southern Taylor, and southern Lincoln Counties. Throughout this district the surface is usually gently rolling, with no lakes and only a few undrained tracts. In the newer drift, which covers the remainder of the area, the surface is more irregular, the drainage systems have not become so well established, and lakes and swamps abound.

In general the soils of northeastern Wisconsin are derived from glacial drift. This drift has been derived largely from the underlying geological formations, of which there are six, and all of these have contributed to a greater or less extent. The uppermost and youngest rock formation is the Trenton limestone. This is confined to the southeastern part of the survey, where it occupies a belt from 6 to 19 miles wide bordering Green Bay. A few outcrops occur, but as a rule there is a thick covering of drift over the rock. Immediately to the west of this is a very narrow belt of St. Peters sandstone, which is here the uppermost rock formation, but there are no outcrops and its influence on the soil formations is almost negligible. The next older formation is the Lower Magnesian limestone, which is quite extensive, occupying a belt from 4 to 12 miles wide parallel to the Trenton formation, and similarly trending across the area from northeast to southwest. Some outcrops occur throughout this region, and this formation, like the Trenton, has contributed materially to the formation of the overlying soils. All three of the formations referred to belong to the Ordovician system of rocks. The next older system represented is the Cambrian, in which the Potsdam sandstone formation is extensively found. It forms the uppermost rock throughout a belt of country 8 to 25 miles wide, also lying in a northeast and southwest direction. This belt extends from near Wausaukee in Marinette County southwesterly to the line between

Grand and Pella Townships in southern Shawano County. This rock weathers readily and no outcrops were observed. The greater part of the region north and west of this formation is underlain by igneous and metamorphic rocks of the Archean system, consisting of granite, gneiss, and schist, with subordinate greenstone, porphyries, syenites, etc. Numerous outcrops occur and the formation has contributed extensively to the overlying soils. Resting upon this formation is the Huronian iron-bearing formation of the Algonkian system. The largest occurrence of this is in the northeastern part of Florence County. In it are iron deposits which are not being worked. Smaller areas of this rock are found in Thunder Mountain in southwestern Marinette County. Another small tract occurs in northeastern Langlade County. The rocks of this formation have contributed only sparingly to the overlying soils.

Eleven soil series and 28 soil types, including Peat and Muck, are recognized and mapped in this survey. The material of which these soils are composed has been derived from glacial till, though some of it has been reworked and redeposited by water and modified by weathering or by the incorporation of organic matter since its deposition. The glacial drift consists of a heterogeneous mixture of sand, gravel, silt, clay, and boulders, and the character of the underlying rock determines to a considerable extent the character of the soil, since the greater part of the glacial drift was carried only short distances by the great ice sheet.

The Miami series of soils comprises the light-colored forested upland soils of the glacial regions, which contain considerable quantities of ground-up limestone, and which have been derived largely from limestone formations. This series is confined to the southeastern part of the present survey, largely to the region where the Trenton and Lower Magnesian limestone formations are the underlying rocks.

The Coloma series is confined largely to the region where Potsdam sandstone is the underlying rock, and where it has contributed most extensively to the formation of the soils. It differs from the Miami series in that the material is noncalcareous.

The Gloucester series consists of light-colored forested upland soils in the glacial regions, where igneous and metamorphic rocks occur and have contributed most largely to the formation of the soils.

The Spencer series includes light-colored forested upland soils where the material forms a part of the older glacial drift formation. This older drift has been derived largely from igneous and metamorphic rocks and is similar in many respects to that of the Gloucester series, except that the material is older and much more thoroughly weathered.

The Fox series is of limited extent in this survey and includes light-colored forested soils of alluvial origin which occur in the glaciated limestone region as glacial outwash plains, stream terraces, or filled-in valleys. There is considerable limestone material in the subsoil.

The Plainfield series bears the same relation to the Coloma and Gloucester series that the Fox series does to the Miami. The Plainfield series consists of light-colored forested soils of alluvial origin which are noncalcareous, and which have been formed as glacial outwash plains, filled-in valleys, or stream terraces, where the material is derived from sandstone. Where the formations which have chiefly given rise to the soil material are granite or otherwise metamorphic the soils are classified with the Merrimac series.

The Superior and Kewaunee series consist chiefly of lacustrine material deposited in quiet waters when Lake Michigan stood at a much higher level than at present. Most of the lacustrine deposits consist of red clay, but since first deposited they have been influenced by glacial action to varying degrees, and as a result layers of sand have in some places been deposited over the clay, or coarser textured material mixed with it. Where undisturbed by glacial action the surface is level, but glaciation has frequently left the surface quite irregular. Where the surface is still level, and the natural drainage therefore defective, the material is classed with the Superior series, but where the surface is gently rolling and the natural surface drainage is adequate, the material is classed with the Kewaunee.

The Poygan series consists of dark-colored lacustrine material, with a red lacustrine subsoil. It is almost the same as the Superior series, but has a sufficient quantity of organic matter in the surface soil to give it a dark or black color.

The Clyde series includes dark-colored soils high in organic matter occupying old lake beds, drainage channels, or ponded valleys. It is partly lacustrine and partly alluvial.

Peat and Muck consist of vegetable matter in varying stages of decomposition.

The following table gives the name and the actual and relative extent of each of the soils mapped in this survey:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Gloucester silt loam.....	156,672	22.9	Miami fine sandy loam.....	275,904	7.4
Rolling phase.....	738,432		Poorly drained phase.....	13,824	
Gloucester fine sandy loam...	428,544	10.9	Muck.....	273,600	7.0
Peat.....	380,736	9.8	Plainfield sand.....	187,776	4.8
Gloucester sandy loam.....	316,224	8.1	Miami loam.....	118,656	3.0
Gloucester fine sand.....	294,336	7.5	Kewaunee fine sandy loam...	108,288	2.8

Areas of different soils—Continued.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Coloma fine sand.....	97,344	2.5	Gloucester sand.....	10,368	0.3
Plainfield fine sand.....	74,304	2.4	Poygan fine sandy loam.....	9,856	.3
Poorly drained phase.....	17,856		Coloma sand.....	9,792	.3
Merrimac silt loam.....	91,584	2.3	Superior fine sand.....	8,704	.2
Spencer silt loam.....	60,480	1.9	Kewaunee clay loam.....	8,128	.2
Level phase.....	14,400		Kewaunee loam.....	7,552	.2
Gloucester stony sand.....	59,328	1.5	Fox fine sandy loam.....	6,976	.2
Coloma fine sandy loam.....	46,656	1.2	Clyde loam.....	6,016	.2
Miami fine sand.....	33,984	.9	Merrimac fine sandy loam.....	4,352	.1
Superior fine sandy loam.....	27,972	.7			
Merrimac sandy loam.....	14,976	.4	Total.....	3,902,720

GLOUCESTER SERIES.

The types of the Gloucester series are light brownish or often grayish at the immediate surface and have yellow subsoils. In many areas the presence of small quantities of mica in the soil and subsoil is a common characteristic though mica is not invariably present. The soils are derived from a rather local glaciation of crystalline rocks consisting chiefly of granite and gneiss, together with a less amount of schist, the material being left as a rather thin mantle of ground moraine. Scattered rocks and boulders of large size occasionally occur, rendering the use of farm machinery difficult. The topography ranges from gently undulating to rolling or hilly, the hills often being quite high, broad, and smoothly rounded. The drainage of these soils is usually fair to good, and in many places excessive. In the original forest growth maple, birch, and hemlock predominate, with varying amounts of white pine and some elm and oak, the cut-over areas being now overrun with a second growth in which birch is common. The soils of this series are in a more or less acid condition. The types mapped in this area are the silt loam, with one phase, the fine sandy loam, sandy loam, sand, fine sand, and stony sand.

GLOUCESTER SILT LOAM.

The Gloucester silt loam is an important and extensive soil in the present survey. It covers a total area of 244.8 square miles and comprises some of the best undeveloped agricultural land in northern Wisconsin. Tracts of considerable size are found along Pine River in western Florence County, to the southwest of Crandon, to the east of Blackwell, and in various other parts of Forest County. In Langlade County there are important areas in northern Elton and Langlade Townships and smaller patches in the southern part of the county (see Pl. XXI). In Shawano County it is confined to a large num-

ber of rather small tracts scattered throughout the western half of the county. It is not extensive in Oconto County, where it is confined to the northwestern section.

The surface soil of the Gloucester silt loam consists of a brown or light-brown, friable, loesslike silt loam extending to an average depth of 12 to 14 inches. The amount of silt is higher and the percentage of coarse material lower than in the rolling phase of this type, and as a whole there is probably slightly more organic matter present. The subsoil consists of a light-yellow or yellowish-brown silt loam to silty clay loam which usually becomes somewhat heavier with depth, and silty clay loam or heavy clay loam is reached at from 18 to 20 inches. This heavy layer usually extends to an average depth of about 30 inches. The lower part of this section frequently contains some sand and the material sometimes becomes a gritty clay loam. Below 30 inches the subsoil grades into a bed of unassorted glacial till consisting of fine and medium sand and gravel with only a small percentage of silt and clay. Stones and boulders are present upon the surface, though they are not so large or so plentiful as on the rolling phase. The distribution of the stones is not at all uniform and there are tracts of considerable extent where they are almost lacking or present in such small quantities as not to interfere with cultivation. It is seldom that large boulders are found on this type, and most of the stones range in diameter from a few inches to 12 or 14 inches. The areas which occur in western Shawano County, however, are more stony and have a greater number of large stones than other portions of the type.

There are a number of variations in this type which are worthy of note. The depth of the silty material over sand and gravel is nearly as variable as in the rolling phase, though on the whole it averages deeper. It very frequently occurs that the unassorted till is 3 or 4 feet or even more below the surface, while there are a few tracts over which it is within 1 foot of the surface and where there is some gravel scattered over the surface of the soil. The shallow silt areas are usually confined to small tracts of the type, and most of the extensive tracts have a silt covering of at least the average depth. In southwestern Shawano County a number of the shallow silt areas are found, and there is also a variation in which there is a considerable proportion of fine sand incorporated with the silt. Such tracts, if of sufficient size, would be mapped as a heavy fine sandy loam or a loam. In such places the subsoil is often a sandy clay loam instead of a silty clay loam or silt loam. Another phase is found in southwestern Shawano County where the subsoil is rather heavy and red in color, resembling the Kewaunee fine sandy loam subsoil. If such tracts were sufficiently extensive to warrant separation they would be classed as the Kewaunee silt loam.

The chief differences between this type and its rolling phase are that its silt covering is deeper, it contains a somewhat higher percentage of silt, there are fewer stones present, a larger proportion of it is stone free, and very few large bowlders 2 feet or more in diameter are found. The most noticeable difference, however, is in the topography. While the rolling phase ranges from gently rolling to hilly and broken, the surface of the typical Gloucester silt loam varies from level to very gently rolling. In most cases the natural drainage is thorough, but where the surface is level or gently undulating and the silty covering is 3 feet or more deep the internal drainage is somewhat deficient and tile drains are very advantageous in improving the land. This soil retains moisture very well, and because of the smooth topography there is no destructive erosion.

The greater part of the type is similar in origin to the rolling phase, though a larger proportion of it is ground moraine. The areas which are gently undulating or nearly level may be in part till plains. It is known that in some places the sandy gravelly material in the deep subsoil is stratified, and such areas are doubtless outwash plains. It is probable that some of the outwash plains have been worked over by an ice sheet after being deposited, and where the surface is not level such tracts more closely resemble the Gloucester than the Plain-field soils. In a detailed survey the outwash plains would be separated from the remainder of the type, but in this general survey in heavily forested regions a separation is usually not practicable. Where feasible, however, it is made. The soil throughout its extent is in an acid condition.

The forest growth consists chiefly of maple, birch, and hemlock, though the hemlock is not as plentiful as on the rolling phase. Basswood, elm, and white pine are found to a less extent. Most of the pine has been cut, but by far the greater part of the hardwood and hemlock is still standing.

Only a comparatively small percentage of this type is cleared and under cultivation, but it gives promise of becoming one of the most highly improved and important soils in the area. Much of this land is still owned in large tracts by lumbering companies, railroads, and individuals, and its development along the line of agriculture is retarded. As rapidly as the timber is removed and the land placed upon the market it is being taken up in small tracts and farms started. The districts where this soil is now being farmed are found chiefly in western Shawano County, southern Langlade County, and in Forest County in the vicinity of North Crandon, and also to the southwest of Crandon.

The crops grown, the methods of farming followed, and the crop rotations practiced are practically the same as on the rolling phase. The main type is considered a more desirable soil than the phase.

There are stone-free areas of considerable size on which such implements as potato diggers can be operated without difficulty, and for this reason it seems probable that the potato-growing industry will develop to a greater extent than on the rolling phase. Alfalfa can be grown successfully, provided the soil is limed and inoculated. Live-stock raising, dairying, potato culture, and small-grain growing seem well adapted to conditions found upon this soil, and most of the development now taking place is along these lines.

The selling price of land of the typical Gloucester silt loam soil averages somewhat higher than that of the rolling phase, because of its smoother topography and the smaller number of stones present, permitting easier clearing and cultivation.

Gloucester silt loam, rolling phase.—The Gloucester silt loam, rolling phase, is closely associated with the typical soil, and is mapped in the same parts of the area. It is the most extensive soil mapped in the survey, and covers 1,153.8 square miles. While not extensively farmed at present, because of the numerous tracts of standing timber, which is still in large holdings, it gives promise of being one of the most important agricultural types of soil in this section of the State when fully developed. It occupies an extensive belt of country in the western half of the survey and reaches from the Michigan-Wisconsin line on the north border of Florence and Forest Counties to the southern boundary of Shawano County, a distance of nearly 100 miles. In Forest County and the western third of Florence County this soil occupies over 50 per cent of the total area, while in eastern and central Langlade and western Shawano Counties it is the predominating soil. It is also found as a narrow belt along the western margin of Marinette County and in the northwestern corner of Oconto County. Associated with this phase is the typical soil and numerous areas of Gloucester sandy loam, fine sandy loam, stony sand, and fine sand. The sandy types occur chiefly as marginal deposits bordering the extensive tracts of the phase, rather than as an extensive sandy deposit within its limits.

The soil of the Gloucester silt loam, rolling phase, to an average depth of 10 to 12 inches consists of a brown or grayish-brown, friable silt loam which has a smooth feel and contains a moderate amount of organic matter. The surface 6 inches is usually somewhat darker than the material immediately beneath because of the larger content of organic matter. When dry, the soil frequently has a gray, ashen appearance. It is usually free from coarse grains of sand and fine gravel, and the smooth, velvety feel is a remarkably uniform characteristic over most of this phase. The soil has somewhat the appearance of loess.

The subsoil of the Gloucester silt loam, rolling phase, consists of a yellow, yellowish-brown, or slightly grayish yellow silt loam which

usually becomes heavier in texture with depth, grading into a silty clay loam at 16 to 20 inches. This heavier material extends to a depth of 20 to 26 inches, where fine gravel or sand is often incorporated with it. Below this depth the percentage of sand and gravel increases, and the lower subsoil usually consists of an unstratified mixture of light-yellowish or brownish fine and medium sand, with considerable quantities of gravel, but only a small proportion of silt and clay. The gravel is sometimes so plentiful as to prevent penetration with the soil auger.

A large number of stones and boulders occur scattered over the surface of this soil. These range in size from a few inches to several feet in diameter. In places the rocks are so numerous as to be a serious obstacle in the clearing of the land, while in other localities the surface is practically free from stones. Because of the irregularity of their occurrence it is impracticable to indicate the stone-free areas. Land where the stones are most abundant, where it is possible to cross a field by stepping from rock to rock, is frequently included in farms, often being pastured and sometimes cleared of stone and cultivated. Tracts as stony as this, however, are of comparatively small extent. Where stones are the most plentiful and fields are cleared, stone fences are common.

There are a number of variations in the Gloucester silt loam, rolling phase, which are worthy of note, although not of sufficient extent or importance to indicate separately on the soil map. On the tops of practically all the hills and ridges the silty covering over the sandy gravelly subsoil is thinner than typical, and on some of the sharpest ridges gravelly material outcrops and gravel is found upon the surface. Toward the foot of the slopes the silt covering gradually becomes deeper, and frequently along the lower slopes and across the valley to the next rise it is so deep that no gravel can be reached with the 3-foot soil auger. Where the slopes are gentle and the hilltops broad and nearly flat, the silt covering frequently continues of uniform depth. In the southeastern part of Forest County in the vicinity of Wabeno the surface soil contains a higher percentage of silt than typical and the subsoil is heavier and deeper, even on the hilltops, than is usually the case. In western Marinette County the phase is a little lighter than typical and is very nearly a loam in texture. In many localities there is a considerable amount of fine sand incorporated in both soil and subsoil, so that the soil approaches a fine sandy loam and would be mapped as a fine sandy loam if the areas were of sufficient size. Such variations occur in secs. 16, 17, 18, 19, and 20, T. 34, R. 10, and in secs. 4, 5, 6, 7, and 8, in T. 33, R. 11, in Langlade County. In the western and southern parts of Shawano County a large proportion of the phase is somewhat lighter in texture than typical and approaches a loam. The ridge tops are

frequently a fine sandy loam, but the lower slopes and intervening lower lands are sufficiently heavy to be classed with the silt loam. This same general region in Shawano County is also more stony than typical, and the country about Tigerton and Splitrock is probably more stony than any other section of the area.

While the variations described above are not of sufficient extent or importance to be shown on a general soil map, a large proportion of them could be indicated in a detail map. If a detail survey were made of this area, the material here included with the rolling phase of the silt loam would probably be separated into the silt loam, fine sandy loam, loam, and gravelly loam.

The surface of the Gloucester silt loam, rolling phase, varies from gently rolling to rolling and hilly, and in a few places to rough and broken, though most of it may be classed as rolling. The surface is often in the form of a series of parallel ridges extending in a north-east and southwest direction. The highest portion of the ridges ranges from 50 to 150 feet above the intervening valley bottoms, but the slopes are seldom too steep to prevent the use of modern farm machinery when the land is cleared. In many localities the slopes are long and gentle and it is frequently one-half mile or a mile, or more, from one hilltop to the next. In the vicinity of Crandon, around Stone Lake, and to the south in Forest County the hills are quite high and some of the slopes steep. To the southwest of Lakewood in Oconto County there is a considerable area which is extremely rough and broken and much of which is too steep for cultivation. This area comprises parts of secs. 35 and 36 in T. 33, R. 15, parts of secs. 31, 32, 33, and 34 in T. 33, R. 16, and parts of secs. 4, 5, 6, and 7, in T. 32, R. 16, Oconto County.

In the depressions between the hills and ridges there are a large number of swamps and lakes. The swamps consist chiefly of areas of Peat and are most numerous in the northern part of Forest County, though marshy tracts occur to a greater or less extent throughout the entire region covered by this soil.

Because of the uneven surface and the loose, open structure of the deep subsoil, the natural surface drainage is excellent and the internal drainage is very good, except in a few places where the silty covering is deeper than usual and the surface is in the form of a valley or small depression, in which case tile drains could doubtless be installed to advantage. On many of the steeper slopes erosion will be a problem requiring attention when the land is cleared and put under cultivation. Where fields have been cleared and cultivated on the steeper slopes, small ravines soon form if the surface of the ground is not covered by a growing crop most of the time. These gullies enlarge quite rapidly and in time cut up the fields badly unless

checked. Fortunately, as the country is new, means of preventing damage from erosion can be adopted as the land is cleared.

The material composing the Gloucester silt loam, rolling phase, has been derived from the weathering of the glacial drift which covers this entire region, ranging in depth from a few feet to over 100 feet. It appears that the surface was considerably eroded before the decomposition of the drift and that the preglacial topography in general was quite similar to the present surface arrangement. The drift forms a veneering over the underlying rocks and was deposited chiefly as ground moraine, though many of the ridges have the appearance of being terminal or recessional moraines, and the hills frequently appear to be elongated drumlins. The mass of glacial deposit consists of a mixture of unassorted gravel, sand, and a small amount of finer material, over which has been placed a comparatively thin layer of silt. It seems probable that this finer material may be in part at least due to the action of wind and therefore of loessial origin. Most of the boulders are of the same material as the underlying crystalline-rock formation.

The timber growth on the Gloucester silt loam, rolling phase, consisted chiefly of hardwoods and hemlock, with a scattering of white and Norway pine. A large proportion of the pine has been cut, but the phase still supports some of the most extensive hardwood forests remaining in Wisconsin. Over the northern part of Forest, the eastern part of Langlade, the northwestern part of Oconto, and in scattered areas in Shawano County there are large tracts of virgin forest. The hardwood consists chiefly of maple and birch with a small amount of basswood and elm and a very little oak. On the heavier areas of this phase maple is always the most abundant, but as the soil becomes lighter in texture the hemlock is more plentiful. Lumbering is a very important industry on this soil phase.

Only a small part of the rolling phase has been put under cultivation, though large areas have been cleared of their timber and are now awaiting the settler. The most extensive developments are in Rolling, Norwood, Polar, and Evergreen Townships in Langlade County and in the western part of Shawano County. Enough has been done along the line of agricultural development, however, to demonstrate that the soil is well adapted to all the general farm crops suitable to the climate and that it is a naturally strong, productive soil and one of the best and most important soils, as well as the most extensive, in the area surveyed. General farming is the chief type of agriculture followed. The tendency seems to be toward the development of dairying and potato culture as the two most important lines of farming.

The chief crops grown are potatoes, hay, and oats, with some corn. Potatoes thrive and seem to be especially suited to the soil and cli-

mate. Yields range from 150 to 200 bushels per acre, often being considerably higher. Oats yield about 50 bushels and hay from 2 to 3 tons per acre. Clover and all kinds of grasses suited to the climate do remarkably well on this soil. Peas are grown to some extent and give very satisfactory yields. Barley, wheat, and sugar beets all grow well but are not produced to any extent in this new country. In the southern part of the area corn is a practically sure crop, being depended upon to mature nearly every year, while in the northern part of the area where this phase occurs the season is somewhat shorter and there is more danger from early fall frosts. Corn for silage, however, can be grown very well over the entire area of this soil, and early maturing varieties are being introduced.

As most of the region covered by the rolling phase is still new, no definite systems of crop rotation or methods of cultivation have been put into general practice. The virgin soil is strong and productive and the question of maintaining soil fertility has not received serious consideration. The greatest problem is getting the land cleared and ready for the plow. The cost of removing the stones is sometimes equal to the cost of removing the stumps, though it is not necessary that either of these should be removed from any large proportion of a farm at first. Usually a tract sufficiently extensive for growing the desired cultivated crops is carefully cleared as rapidly as possible and the remainder brushed and seeded. Excellent grazing is thus afforded and after a few years the hardwood stumps will be sufficiently decayed to be readily taken out. As long as the land is used for grazing the stones are no serious handicap. Probably as much as 40 per cent of the phase is stone-free, or the stones and bowlders are present on the surface in such small quantities that they do not interfere with the agricultural development or detract from the agricultural value of the soil.

In development and improvement of this phase it should be borne in mind that while there is now a moderate amount of organic matter present, this supply will be exhausted in a few years if the system of farming followed does not provide for the return of considerable organic matter to the soil.

The Gloucester silt loam, with its rolling phase, offers more opportunities for agricultural development than any other soil in the area surveyed, and where it predominates the prosperity of the community depends chiefly upon its development and improvement.

Cut-over land of this phase ranges in price from about \$12 to \$25 an acre, depending chiefly upon the location. Forested land ranges from \$18 to about \$50 an acre, according to the location and stand of timber. Partly improved farms are valued at \$35 to \$50 or \$60 an acre, depending upon the location, buildings, and the amount of land cleared and under cultivation.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the typical Gloucester silt loam:

Mechanical analyses of Gloucester silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
311701.....	Soil.....	2.0	6.0	7.2	9.8	9.6	52.4	13.0
311702.....	Subsoil.....	3.4	14.1	18.4	25.3	11.3	21.0	6.6

GLOUCESTER FINE SANDY LOAM.

The Gloucester fine sandy loam is one of the most extensive soil types in the area surveyed, and covers 669.6 square miles. It is found in all of the six counties where crystalline rocks make up the underlying geologic formation, but it is most extensive in Marinette and Shawano Counties. The general occurrence of the type is in-extensive, irregular belts running in a northeast and southwest direction, following the trend of the glacial ice sheet which covered this region. The type is closely associated with the Gloucester fine sand on the one hand and the Gloucester silt loam on the other. Along the southern border of its occurrence in Marinette, Oconto, and Shawano Counties it grades into soils of the Coloma series with such a gradual change that the line between the two series is largely arbitrary.

The surface soil of the Gloucester fine sandy loam to an average depth of 12 inches consists of a light-brown or yellowish-brown, mellow, friable fine sandy loam. The surface soil of cultivated fields when thoroughly dried is grayish, but becomes somewhat darker as the content of moisture increases. The subsoil consists of a light yellowish brown to yellow fine sandy loam which usually becomes coarser in texture and somewhat lighter in color with increased depth, so that the last 6 to 10 inches in the 3-foot section is mainly yellow sand and gravel. It is not uncommon, however, to encounter a rather compact gravelly sandy loam at 20 to 24 inches which may or may not change to sand and gravel before a depth of 36 inches is reached. Some gravel and stones occur throughout the 3-foot section and there may be a scattering upon the surface. The greatest amount of gravel occurs below a depth of 18 or 20 inches. Stones and boulders are plentiful on the surface and through the soil section, ranging in size up to 3 feet in diameter, but are rarely so numerous as on the Gloucester silt loam, rolling phase. Their occurrence is irregular and there are areas of considerable size which are practically stone free, but as the type is forested it is impracticable to attempt a separation on the map on the basis of stone content. The portion of the type mapped in southwestern Shawano County

is stonier than elsewhere and the bedrock is sometimes encountered within 3 feet of the surface. Rock outcrops are common.

A variation from the typical soil was noted west of Mountain in Oconto County, where the surface soil is a yellowish-brown to brown silty fine sandy loam to a depth of 16 to 18 inches. The subsoil is a yellowish-brown sandy loam carrying considerable gravel and small stones. The surface is somewhat more stony than usual. Below 30 inches a mixture of yellow sand, gravel, and stones is frequently encountered. This phase may be considered as an intermediate soil between the typical Gloucester fine sandy loam and the loam, though as a whole it more closely resembles the fine sandy loam. Other variations of this kind occur in Shawano County, but are of more limited extent. In southwestern Shawano County there are a number of small tracts where the subsoil below 14 inches has a reddish tinge and is a sticky fine sandy loam. Where the type approaches or borders the region mapped as Kewaunee fine sandy loam the deep subsoil is frequently a brownish-red sandy clay and in a few places a clay loam. The change from the Gloucester to the Kewaunee fine sandy loam is a very gradual one, and in this general survey some small areas of one type are included with the other. In a detailed survey this and other variations could be indicated separately on the soil map.

The surface of this type varies from gently rolling to rolling and hilly. As a type it is not quite as rough as the rolling phase of the Gloucester silt loam, though under continued cultivation there would probably be some damage from erosion, especially where the heavy phase occupies the steeper slopes. Over most of the type erosion will not be a serious matter, owing to the character of the soil and subsoil. There are a few places of rather limited extent where the surface is only undulating and where the material is apparently derived from an outwash plain. Such an area occurs due east of Boot and Pickerel Lakes in Florence County, and a similar one in secs. 33 and 34, T. 34, R. 10, in Langlade County. A few other areas exist, but these are so small that their separation is impracticable. On account of the uneven surface features of this type the natural surface drainage is good, and as the internal drainage is also free and inclined to be excessive, owing to the loose, open structure of the subsoil, the type when cleared and cultivated is likely to suffer at times from drought, though this should not be at all serious and will not retard its agricultural development.

This type owes its origin to the weathering of glacial till which was deposited over the crystalline rocks; and it consists of material which was derived largely from this geologic formation through the grinding action of the ice and subsequent weathering. A part of the type may consist of lateral or recessional moraines.

The forest growth over this type consists of a mixture of white pine, hemlock, and hardwoods. On the lighter and coarser textured phases some Norway pine is found. Hemlock and maple are the most plentiful, though there is also considerable admixture of birch, basswood, some oak, and a little elm. Over the eastern areas of the type there is also some beech; this growth decreases with the distance from Lake Michigan. In Marinette County white and Norway pine seem to be the predominating growth, together with white birch and red oak. Hemlock, maple, and elm do not seem to thrive so well as on the Miami fine sandy loam. In southwestern Shawano County but little pine grows with the hardwood and hemlock. Practically all the pine has been cut, and also some of the hardwood, though there are still extensive virgin forests of the latter on this soil.

Probably not over 10 per cent of this type is in improved farms, but it is a good, productive soil, and is well suited to a wide range of crops. Farming on the Gloucester fine sandy loam in this region is new and not well developed or defined. The chief crops are oats, rye, potatoes, timothy and clover, hay, and corn. Buckwheat, peas, sugar beets, and cucumbers are grown to a small extent. From the limited data available concerning the crops on this soil it appears that the yields are about as follows: Oats, 30 to 45 bushels; potatoes, 100 to 200 bushels; rye, 15 to 20 bushels; corn, 35 to 50 bushels; hay, 1½ to 2 tons; buckwheat, 20 to 22 bushels; peas, 16 to 18 bushels; sugar beets, 9 to 12 tons; and cucumbers, 3 to 3½ tons per acre. When the soil is new clover does well. On older fields, however, some difficulty may be experienced in getting a good stand, probably on account of the acid condition, the effect of which is more apparent as the productiveness of the soil is reduced. Alfalfa is grown in places; its success on this soil depends upon liming and inoculation.

There is a thriving apple orchard of over 750 trees just south of Mountain, Oconto County, where Red Astrachan, Early Harvest, Duchess, Wealthy, Snow, and Longfield are among the varieties successfully grown, with several varieties of crab apples. There are a large number of good orchard sites on this soil and it is probable that apple culture is feasible on an extensive commercial scale. Concord grapes do well, especially around Mountain, and are almost certain to ripen and produce satisfactory yields. Bush fruits such as raspberries and blackberries are found growing wild through all of the slashings, and the type is well suited to such fruits, including strawberries. The truck industry can be extended on this soil as shipping facilities are improved.

Dairying is becoming more important as settlement increases. With dairying as the leading industry the productiveness of the soil is readily maintained or increased. The silo is being introduced on

the dairy farms, as sufficient corn for silage can always be grown. During most seasons corn will mature, especially the flint and some of the early dent varieties. It is probable that potato growing and dairying will develop together, as corn and potatoes are good supplementary crops under the soil and climatic conditions.

Wild cut-over land of the Gloucester fine sandy loam sells at \$10 to \$25 an acre and partly improved farms at \$35 to \$60 an acre, depending upon the location and improvements. The quantity of stones present is also a factor in determining the value.

GLOUCESTER FINE SAND.

The Gloucester fine sand is one of the extensive soil types in the present survey and covers a total area of 459.9 square miles, of which about one-half is found in Marinette County. Oconto, Florence, and Shawano Counties contain from 50 to 100 square miles each, but Forest and Langlade Counties have only a few square miles each of this soil. The type occurs in extensive, rather irregular belts having a northeast and southwest trend. The most extensive of these belts begins in the eastern part of Florence County and extends southwestward through Marinette County into the northeastern part of Oconto County, where it becomes less prominent. This strip, reduced in width and consisting of irregular, detached areas, reaches across Oconto County to the point where the Wolf River crosses the Shawano-Oconto County line. To the north and northwest of this point, through the eastern part of the Menominee Indian Reservation, there are also extensive tracts of this soil, chiefly within 5 or 6 miles of the Wolf River. Other small tracts occur in various parts of the area where the underlying rock is chiefly granite. The type is closely associated with the Gloucester fine sandy loam and with the sandy soils of the Plainfield series.

The surface soil of the Gloucester fine sand, to an average depth of 9 to 10 inches, consists of a loose, friable, yellowish-brown fine sand. The surface inch on virgin tracts is often a little darker, due to a small accumulation of organic matter, but where the land has been burned over, as is very often the case, the surface has a grayish appearance. The subsoil consists of a yellow fine sand which usually becomes somewhat coarser in texture and a little lighter in color with depth. In places the lower part of the 3-foot section contains varying amounts of fine gravel and some stone. Ordinarily, however, the gravel is not very plentiful within 36 inches of the surface. Stones and boulders may be present in moderate quantities on the surface and mixed with the soil, though there are extensive stone-free areas. There are fewer stones and boulders on this type than on the sandy loam or fine sandy loam of the Gloucester series, but rock outcrops are more numerous than on any of the other soil types of the area.



GLOUCESTER SILT LOAM, LANGLADE COUNTY.

Note the undulating topography and general appearance of prosperity.



GLoucester FINE SAND NORTHEAST OF MOUNTAIN, OCONTO COUNTY.

This shows the characteristic topography, nature of uncleared land, and tilled fields. The original timber was chiefly jack and Norway pine. Present growth scrub oak, pine, and poplar.



GLOUCESTER SANDY LOAM SOUTHEAST OF ANTIGO, LANGLADE COUNTY.

Note the rolling surface features and timber growth. Original timber mixed hardwood and pine. This topography is also characteristic of the Gloucester fine sandy loam.



MIAMI FINE SANDY LOAM NEAR GILLETT, OCONTO COUNTY.

Note the topography and well-improved farm. Second crop of clover in foreground.

Extending through Oconto and Marinette Counties and into Florence County where this type occurs there is a series of extensive outcrops of granitic rocks, which in places are so large or numerous that frequently areas of a square mile are of little or no agricultural value. The proportion of the entire type covered by such ledges, however is comparatively small.

A heavy phase of this type, consisting of a loamy fine sand, is found in sec. 3, T. 33, R. 17, and in portions of T. 33, R. 16, in Oconto County. Similar areas occur in the Menominee Indian Reservation in Shawano County, though these are not extensive. A coarse phase of this type occurs in the northeastern part of Oconto County, in small tracts in northeastern Shawano County, and in a few patches in eastern Florence and in Marinette Counties. In such places there is frequently some fine gravel present on the surface and mixed with the surface soil.

The surface of the Gloucester fine sand varies from undulating to gently rolling, with some areas that consist of low hills, giving a hummocky appearance (see Pl. XXII). The surface is not as rough and broken as that of the fine sandy loam or the sandy loam of the same series. The slopes are usually long and gentle, so that from a consideration solely of topography none of the type would be difficult to cultivate. Owing to the character of the surface and the loose structure of the soil, the natural drainage is good and the internal drainage is excessive, so that crops very frequently suffer from lack of moisture. Erosion will not be serious on this type, since the soil absorbs water so rapidly that there is usually no surface run-off.

This type owes its origin to the weathering of glacial drift, most of which was derived from the grinding action of the ice sheet over the crystalline rocks of this region. The type differs in this respect from the Coloma fine sand, which is derived from sandstone. Owing to the fact that the Gloucester soils are derived chiefly from granitic rocks, they usually contain more of the essential elements of plant food than the Coloma soils of the same texture, which are derived from sandstone, and are somewhat more productive. There are no traces of limestone or calcareous material in this soil.

The original forest growth consisted of white and Norway pine with some jack pine and scrub oak in a number of places. All of the valuable white and Norway pine has been removed, and the present growth, which is sparse, consists of small Norway pine, jack pine, scrub oak, and white birch. A few white pine trees are frequently seen, but seldom any of present merchantable value. Fires have burned over large areas of this soil so frequently that in many places there is no tree growth, the land is practically cleared of all stump and brush, and the only growth consists of sweet fern, blueberry bushes, sand cherries, and some prairie grass.

Probably not over 2 or 3 per cent of this type is under cultivation at present. In the vicinity of Florence in Florence County, at Mountain and Breed in Oconto County, and in a few localities in Marinette County, more of this soil is farmed than elsewhere. The crops grown and yields obtained are: Corn, 20 to 35 bushels; oats, 25 to 35 bushels; peas, 17 bushels; potatoes, 100 to 150 bushels; rye, 12 to 18 bushels; buckwheat, 12 to 15 bushels; and hay, about three-fourths ton per acre. Potatoes constitute the most important cash crop and tubers of very good quality are grown.

The cost of clearing this land is comparatively low. Some tracts require but little effort. It should be kept in mind, however, that the soil is low in organic matter, has a rather low water-holding capacity, and is acid. It can be built up more readily than the Coloma fine sand, Coloma sand, or Gloucester sand, but in order to insure profitable returns from year to year careful management is necessary. The type is naturally well suited to truck crops, and favorably located areas could well be devoted to trucking. Strawberries, bush berries, cucumbers, peas, beans, etc., do well and would yield profitably if cultivated intensively.

Wild land of this type sells for \$5, or even less, to \$20 an acre, depending upon the location, surface features, and cost of clearing. Improved farms sell for \$30 to \$50 an acre, depending upon the location, amount of cleared land, and the value of farm buildings.

GLoucester SANDY LOAM.

The Gloucester sandy loam is quite widely distributed over portions of five of the six counties included in the present survey and comprises a total area of 494.1 square miles. The principal development is in Langlade County. In Forest County there is another extensive body of this soil, lying in a belt about 21 miles long between Newald on the north and Roberts, Himley, and Richardson Lakes on the south, and about 7 miles wide between Rat Lake and Birch Lake. In the northwestern and northern parts of Forest County there is a large aggregate area of this soil. Smaller, irregular tracts are scattered throughout Oconto, western Florence, and central Shawano Counties.

The surface soil of the Gloucester sandy loam to an average depth of about 12 inches consists of a brown or slightly yellowish brown, medium-textured sandy loam of a rather loose and friable structure. When thoroughly dry it frequently has a grayish appearance, especially in cultivated fields where the amount of organic matter is smaller than in the virgin soil. The subsoil gradually becomes lighter in color and frequently coarser in texture with depth, and below 22 inches it consists of an unstratified mixture of medium to coarse sand and fine gravel. Gravel frequently is scattered over the surface in small quantities. Stones and boulders up to 3 or 4 feet in diameter are scattered over the surface and mixed with the soil material, but

they are not so numerous as on the rolling phase of the silt loam of this series. The extremely large bowlders are less numerous than those ranging from 10 to 18 inches in diameter. There are areas of varying size scattered over the type which are stone free or nearly so, but it is not practicable to separate such tracts in a general survey of this kind. Where the stones are most numerous the cost of removing them is nearly as great as that of removing the stumps, though over much of the type their presence does not seriously interfere with agricultural development.

A number of variations occur in this type. In Rolling Township in the southern part of Langlade County the soil is somewhat heavier, is less rolling, has fewer stones, and taken as a whole is somewhat better for all agricultural purposes than the typical. Farming is better developed on this tract than elsewhere in the area. In the western part of Upham Township the type is more gravelly than usual and the texture is variable within short distances. In places it is a loam or gravelly loam, while again it may be a fine sandy loam or gravelly sand. Such variations, however, are too limited in extent to be indicated. In the extreme northwestern corner of Langlade County, in T. 34, R. 9, and in the extreme southeastern part, in T. 32, R. 14, and T. 31, R. 14, the type is more stony, gravelly, and rougher than usual and has a lower agricultural value. In some places it is a gravelly sand. Excavations and well records show that the subsoil of sand and gravel extends to bedrock, and that the huge bowlders occur to a depth of 20 to 30 feet.

Wherever narrow ridges occur throughout this type the soil on the summit is shallow and the gravelly sand occurs at the surface, with a gravelly subsoil. Such tracts are of small extent, but are not uncommon, and their presence detracts somewhat from the value of the land.

The surface of the Gloucester sandy loam varies from rolling to rough and hilly (see Pl. XXIII). Over the greater part of the type the surface is not too steep for cultivation, but there are exceptions to this where the topography is so broken and the slopes so steep that cultivated crops probably could not be produced with profit. In the extreme northern part of Forest County, in the northwestern part of Langlade County, in T. 34, R. 9 (except in secs. 17 and 18, where the surface for about 1 square mile is only gently undulating), and in the vicinity of Rose and Edith Lakes, in T. 32, R. 14, the surface is very rough and the land has a low agricultural value. The surface frequently appears as a series of parallel ridges varying in elevation from 15 to 40 feet above the intervening valleys and occurring from 20 rods to one-fourth mile apart. The slopes are sometimes quite steep and in general outline they have the appearance of eskers, but the material is not stratified.

On account of the uneven surface features of this type and the loose, open structure of most of the material, the natural surface drainage is good, the internal drainage is excessive, and the soil suffers from drought during a part of practically every growing season to such an extent as to materially reduce its productiveness. There are a number of depressions throughout the type in which lakes or beds of Peat occur

The material composing the Gloucester sandy loam consists of glacial *débris* deposited by the ice sheet over the region of crystalline rocks, the material being largely derived from the grinding up of these rocks. The roughest portions of the type are probably lateral or recessional moraines, though the greater part consists of ground moraine material. A few eskers also occur, but they are of only limited extent, and the type as a whole consists of unassorted glacial till. It is not probable that a large part of the material forming the soil has been transported a long distance, and but little of it has come from formations not found in the immediate region. In its composition, therefore, it has nearly the same relation to the underlying rock that a residual soil would have.

The original timber consisted of a mixed growth of pine, hemlock, and hardwoods, including maple, birch, and some elm and basswood. In places, especially where the soil is lighter than typical, pine was the predominating growth, while in regions where the soil is a sandy loam or heavier, maple and hemlock predominated. Practically all of the pine has been removed, as have also large tracts of hemlock and the hardwoods. There are, however, extensive areas of this type which still support the virgin forest.

Only a small part of this type, probably not more than 8 or 10 per cent, is cleared and under cultivation. The portion which is the most highly developed is that in Rolling Township in Langlade County. Rye, potatoes, corn, oats, and hay are the chief crops grown and fair yields are usually secured where improved methods are followed. The potatoes are of good quality and constitute the most important cash crop on this type. The stony character of the soil, however, usually prevents the use of the potato digger and other improved machinery. The rotation most commonly followed consists of corn or potatoes, then rye or oats, followed by clover and timothy. The supply of stable manure is small and green manuring is not common. Dairying is carried on to a small extent and seems to be growing in favor.

In other portions of the area surveyed but little of this type is under cultivation. As a whole it requires more careful management than the fine sandy loam or silt loam and is not considered as good a soil as either of those types. The supply of organic matter is low and the soil is acid and rather droughty. In addition the surface is stony and often quite rolling, making cultivation difficult. Cut-over land of this

type fairly well located sells for \$8 to \$12 an acre, though much of it can be bought for considerably less. When improved it ranges in value from \$30 to \$40 an acre, depending upon the amount of improved land, location, and the character of improvements.

The results of mechanical analyses of samples of the soil and subsoil of the Gloucester sandy loam are given in the following table:

Mechanical analyses of Gloucester sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
311754.....	Soil.....	4.0	18.0	19.2	22.6	7.8	20.4	7.9
311755.....	Subsoil.....	3.8	14.2	24.0	27.8	8.0	15.5	6.8

GLOUCESTER SAND.

The Gloucester sand is of very small extent and of minor importance. It occupies only 16.2 square miles in the area surveyed. A few small tracts are found in Elcho and Ainsworth Townships in the north-central part of Langlade County, in the northwestern corner of Oconto County about Boot Lake, and in Pella, Herman, Fairbanks, and Germania Townships in Shawano County.

The surface soil of the Gloucester sand consists of a light-brown medium sand which extends to an average depth of 8 inches. The material is loose and open in structure, contains only a small amount of organic matter, and is in an acid condition. The subsoil consists of a yellow medium sand which becomes slightly coarser and often somewhat lighter in color with depth. Some fine gravel may occur in the deep subsoil and occasionally there is a small amount scattered over the surface. A few stones may also appear upon the surface, but never in such quantities as to interfere with cultivation.

The surface of the type is gently rolling for the most part, and in some places hilly. Owing to the surface features and the loose, open character of the soil and subsoil, the natural surface drainage is good and the internal drainage excessive, so that crops suffer from lack of moisture during practically every season.

The material composing this type consists of glacial débris which has been ground from the underlying crystalline rock and not transported for any great distance. There is no limestone material present.

The original forest growth consisted chiefly of white and Norway pine, with jack pine in places and an occasional scattering of hardwood, though the latter was never plentiful. Practically all the timber of any value has been removed from this type and most of it is now in slashing, some of which has been burned over.

Only a very small part of this soil is cleared and under cultivation, and because of its low agricultural value it is not probable that it will be improved rapidly except in the most favorable locations. The portion of this soil in the vicinity of Tigerton in Shawano County is better than the average and some very satisfactory crops are grown. Corn, rye, potatoes, clover, beans, and oats are the chief crops. Beans constitute a new crop for that section, but are giving very fair results. The yields of the general farm crops are considerably lower than on the silt loam and fine sandy loam types, but potatoes seem to do well, and, where green manuring is practiced and organic matter is returned to the soil, fair yields of all the crops common to this region are obtained.

The selling price of unimproved land of this type ranges from \$4 to \$20 an acre, depending upon the location. Improved farms range in value from \$25 to \$40, or even more, an acre, depending upon the location and improvements.

GLoucester Stony Sand.

The Gloucester stony sand occupies a total area of 92.7 square miles and is a type of minor importance. It has a lower agricultural value than any of the other upland soils of the area surveyed. The largest tract is found in northern and northwestern Forest County and in the western half of Florence County, chiefly along the Popple River to the northwest of Fence. There is also some of this soil in northern Oconto County, and small patches occur in the northern part of Langlade County along the Wolf River.

The surface soil of the Gloucester stony sand to an average depth of 8 to 10 inches consists of a yellowish-brown or yellow, loose, incoherent, medium sand. The surface inch or two frequently has a grayish color. The amount of organic matter present is very small. The subsoil consists of a loose, incoherent, yellow sand which becomes coarser and usually somewhat lighter in color with depth. Gravel also occurs in the subsoil and the amount of this usually increases until at 2 to 3 feet the material frequently consists of a coarse gravelly sand. Stones are very plentiful upon the surface and some large boulders also are found. On many of the ridges and hilltops gravel occurs at the surface. While there are some stone-free tracts of small extent, the stones and boulders are sometimes so plentiful as to almost justify calling this Rough stony land.

The surface of this type varies from rolling to bumpy and choppy. Kames and eskers make up a considerable proportion of the type and the surface is everywhere very irregular and rough. Long, narrow, gravelly ridges frequently alternate with a series of rounded but steep hills so that even though the soil were heavy the topography would make it of low agricultural value. The surface is so irregular and the

soil so open and porous that the natural drainage is excessive and the type very droughty.

The material composing the stony sand consists of glacial *débris* which has been deposited as kames, eskers, and probably as lateral and recessional moraines. The glacial drift was doubtless all derived from the underlying crystalline rocks through the grinding action of the glacial ice sheet. The gravel, stones, and boulders are largely of crystalline rocks. There is no trace of any limestone material in the drift and both soil and subsoil are quite acid.

The original timber growth consisted chiefly of white, Norway, and jack pine. There are a few tracts of small extent where some hemlock and maple grow, but in these localities the topography is so rough and the surface so stony that the agricultural value is considered no greater than the average of the type. A tract of this kind occurs in the area included by Long, Fay, and Halzey Lakes in Florence County. Practically all of the timber of any value has been removed from the type except in the hardwood tracts and there is now a scattering growth of poplar, birch, and wild cherry, with sweet fern growing in abundance.

On account of the loose, droughty nature of this soil, its stony, bowldery surface, and its uneven, broken topography, it has very little value for farming purposes and may well be considered non-agricultural. It is not considered practicable to grow cultivated crops on soil of this character, and it will doubtless remain in its present unimproved condition for a long time. The whole type might well be reforested, but such an enterprise can well be undertaken only by the State or National Government, and not by individuals.

COLOMA SERIES.

The soils of the Coloma series are light brown to grayish above, with yellow to reddish subsoils. They are usually leachy and inclined to be droughty, producing light yields of farm crops. The topography is generally rolling to rough and hilly, representing terminal and ground moraines. These soils are typically developed in northern Michigan, Wisconsin, and Minnesota. They once supported extensive pine forests. The series is formed from relatively coarse glacial material, modified to some extent by the action of wind and water. The Coloma soils are all in a more or less acid condition. The types mapped in this area are the Coloma fine sandy loam, fine sand, and sand.

COLOMA FINE SANDY LOAM.

The Coloma fine sandy loam is confined to Marinette and Oconto Counties, where it occupies a total area of 72.9 square miles. It occurs as a somewhat irregular belt about 4 miles wide extending

to the southwest from the vicinity of Wausaukee in Marinette County to White Potato Lake in Brazeau Township in Oconto County. About 90 per cent of the type is in Marinette County.

The surface soil of the Coloma fine sandy loam to an average depth of 10 inches consists of a light-brown or grayish-brown, loose fine sandy loam which in a few places gives way to a medium-textured sandy loam. There is present only a comparatively small amount of organic matter, but there is sufficient fine material, consisting chiefly of silt, to impart a somewhat loamy character to the soil. The subsoil to a depth of about 24 inches consists of a light-textured fine to medium sandy loam of a lighter color than the surface soil. At 24 to 36 inches this grades into a light-yellow medium sand. There are over small areas a few glacial boulders, chiefly of granitic origin, upon the surface, but these are never present in such quantities as to interfere with cultivation, and most of them are less than 1 foot in diameter. By far the greater part of the type is free from stones, and gravel is not found except in a very few spots.

This type very closely resembles the Gloucester fine sandy loam, but differs from that soil in having only a very few stones upon the surface and a rather less broken topography, and in being derived largely from sandstone instead of from crystalline rocks. Because of the difference in origin, this type appears to have a somewhat lower agricultural value than the Gloucester fine sandy loam.

The surface of this type varies from gently rolling to rolling and there are a few places which could be classed as hilly. Owing to the surface features and the loose character of the subsoil, the type is thoroughly drained. The internal drainage is somewhat excessive and crops are likely to suffer from drought during the latter part of each growing season.

The material composing the Coloma fine sandy loam consists of glacial débris which has been derived largely from the underlying Potsdam sandstone and reduced to its present condition through the grinding action of the ice and subsequent weathering. As is indicated by the presence of a few granitic boulders, it is probable that there is a small amount of material from the granitic rocks which has been carried by the glacial ice from the older formations to the north and mixed with weathered sandstone material. There are no traces of limestone present.

The native timber growth on this type consisted of mixed pine and hardwood. The present growth is largely white and Norway pine, with white birch, some beech, and red oak. The hemlock, basswood, maple, and elm do not seem to thrive as they do on the heavier Miami fine sandy loam. Practically all of the merchantable timber has been removed.

Only a very small part of this type has been placed under cultivation. Sufficient demonstration work has been done, however, to indicate that it is capable of producing reasonably good yields of all the general farm crops commonly grown in this region. Observations in the field indicate that the average yields probably range a little lower than on the Gloucester fine sandy loam, though such a comparison is difficult to make as only a very small part of either soil is cultivated. The Coloma fine sandy loam is not as productive a soil as the Miami fine sandy loam, but it is a type which can be successfully and profitably farmed.

COLOMA FINE SAND.

The Coloma fine sand comprises a total area of 152.1 square miles. The largest tract occurs immediately north of Shawano Lake and east of the Wolf River in Shawano County and the southwestern part of Oconto County. From this area an irregular, broken belt of the same soil extends to the northeast through Oconto County and terminates in Marinette County.

The surface soil of the Coloma fine sand to an average depth of 8 inches consists of a yellowish-brown, loose, incoherent fine sand which contains only very small quantities of organic matter. There are no stones and boulders present upon the surface and the soil is free from gravel except in a very few instances. The subsoil consists of a yellow fine sand which frequently becomes coarser in texture and a little lighter in color with depth, until a medium sand is encountered at 36 inches. Where the type borders soils of the Gloucester series there is sometimes a small amount of fine gravel in the lower subsoil.

The surface of the Coloma fine sand varies from undulating to gently rolling or rolling. The greater portion ranges from gently rolling to rolling. On account of the surface features and the loose, open structure of the material, the drainage is excessive and the type is droughty. The sand is subject to drifting and sand dunes are quite common on this type.

The material composing this soil consists of glacial débris which has been ground from the underlying Potsdam sandstone by the ice. In some places, especially along the northern border, there is a small amount of gravel present, which indicates that some of the soil material may have been transported to this region from crystalline rock formations to the north and mixed with the sandstone material. There is no trace of limestone in either soil or subsoil.

The original timber growth consisted of scattered white and Norway pine, with some localities entirely covered with jack pine. In a few places there is a growth of oak, but this is usually stunted and of little

value. Practically all the merchantable timber has been removed, fires have burned over most of the type, and considerable tracts are so nearly cleared that it seems they had never supported a forest growth. Sweet fern, blueberry bushes, scrub oak, white birch, and a little poplar, with here and there a white pine, Norway pine or jack pine tree, make up the present growth on the Coloma fine sand.

Not over 2 per cent of the Coloma fine sand is under cultivation. The portions most extensively developed are between Shawano and Keshena in Shawano County, in the vicinity of Breed and in Underhill Township in Oconto County. The chief crops grown are potatoes, corn, and rye, with some hay. Fairly good yields are possible the first few years, but unless the best methods of soil management are followed yields rapidly decline to a point where they are not profitable. The soil is well suited to a number of truck crops and where favorably located trucking might be successful.

COLOMA SAND.

The Coloma sand is of small extent and minor importance in the present survey. It occupies a total area of 15.3 square miles and is confined to Shawano County, occurring mainly northwest of Shawano in Richmond Township.

The surface soil of the Coloma sand to an average depth of 8 inches consists of a light-brown, loose, incoherent sand of medium texture which contains only a very small percentage of organic matter. The subsoil consists of a yellow medium sand which usually becomes coarser with depth and often lighter in color until at 30 to 36 inches the material is a pale-yellow, coarse to medium sand. Fine gravel may be present in the deep subsoil, but no gravel beds are associated with this soil in the present survey. There are a few granitic boulders upon the surface, and in places small quantities of gravel, but neither stone nor gravel is so abundant as to interfere with cultivation.

The surface of the Coloma sand varies from gently rolling to rolling, and in a few areas the surface is undulating. On account of the surface features and the loose, open structure of the material the drainage is excessive and the type is droughty.

The material composing this type consists of glacial débris which was derived chiefly from the underlying Potsdam sandstone by glacial action. The presence of a few granitic boulders and gravel indicates that there is probably a small amount of material from the region of granitic rocks to the north, which was transported and mixed with the disintegrated sandstone. There is no trace of limestone in the soil or subsoil.

The original forest growth consisted chiefly of white pine with some Norway pine. In places there was a little oak, but the growth was stunted. All of the merchantable timber has been removed, and the

greater part of the type is now stump land. In places there is a second growth of white birch and poplar. Sweet fern is common over most of the type.

Not over 15 per cent of this type is under cultivation. The soil has a low agricultural value and requires very careful management to keep up the productiveness. The crops most commonly grown are potatoes, corn, rye, and oats, with some hay. The soil is adapted to early truck crops. The yields of all crops are low and the methods followed at present are not such as tend to increase the producing power of the soil.

SPENCER SERIES.

The soils of the Spencer series are brown with a reddish tinge. The subsoils are yellowish-brown with a reddish-pink tinge and are mottled gray and rusty brown with some yellow. The mottling may occur from the surface downward or begin about a foot below the surface. The subsoils are usually more compact and heavier than the soil, and the deeper subsoils are often noticeably redder than the upper subsoils. The series is derived from light-colored igneous rocks mainly, but contains a noticeable percentage of the dark-colored eruptives, as well as the reddish eruptives, from the Lake Superior region. The soils are from material of the old Wisconsin Drift formation. They are upland timbered types, usually having fair drainage. The topography is undulating to gently rolling. Only one type, the Spencer silt loam, was mapped in the present survey.

SPENCER SILT LOAM.

The Spencer silt loam is one of the most important and extensive soil types in northern Wisconsin, but within the area covered by the present survey it occupies, with its level phase, only 117 square miles, and is confined to the western part of Langlade County, where it occurs as one continuous tract in Summit, Vilas, Ackley, and the western part of Peck and Upham Townships.

The surface soil of the Spencer silt loam to an average depth of 10 inches consists of a light-brown or grayish silt loam with a reddish shade, containing only a moderate amount of organic matter. The percentage of silt is high and the soil has the smooth feel characteristic of silt loam. The type is somewhat heavier and more compact, however, than the other silt loam soils of the area, because of the higher clay content, and in a few places it approaches a silty clay loam in texture. The subsoil consists of a yellowish-brown, buff or grayish silt loam which gradually becomes heavier with depth and grades into a silty clay loam or clay loam at 16 to 20 inches. Below this depth and at times above it the material is usually mottled with yellow, brown, bluish, and reddish brown; indicating poor internal drainage. The lower subsoil below 24 to 30 inches has a pro-

nounced reddish-brown color which continues throughout the entire area, though its depth may be somewhat variable. In the lower subsoil there are usually small, irregular rock fragments, fine gravel, or particles of fine and medium sand which give the material a rather gritty feel. The material is heavier and more compact than the soil and because of its impervious, tenacious character it is often spoken of as "hardpan," though this is somewhat misleading, as it is not a true hardpan layer. Where the drainage conditions are the most deficient this reddish-brown material gives place to bluish gritty clay, which is also mottled.

While there are a few stones found upon the surface ranging in diameter from 4 to 10 inches, they are not nearly so plentiful as on the Gloucester silt loam and do not interfere with cultivation to any marked extent. There may also be a scanty sprinkling of gravel on the surface in places, but it is seldom that any stones or gravel occur mixed with the surface soil. While the amount of organic matter in the soil varies somewhat, being greater in the depressions where there has been more accumulation, the texture, structure, and color of the type as a whole are remarkably uniform. Over the entire type an acid condition has developed and in most places this is very marked. Rock outcrops are uncommon. From the records available it appears that the depth to bedrock over the type as a whole ranges from 4 to 50 feet.

The surface of the typical portion of the Spencer silt loam as found in the present survey varies from undulating to gently rolling. The difference in elevation between the highest and lowest points probably does not exceed 40 feet, and all the slopes are long and gentle. Over most of the type, except the level phase, the natural surface drainage is fairly good, though there are a few low places where the surface is wet much of the time. These low places, however, are not swamps or peaty areas and as the land is cleared and put under cultivation the surplus water content withdraws without artificial drainage to the extent that crops can be grown. In such places, however, and even on many of the gentle slopes tiling would prove a profitable investment, because the internal drainage of all of the type is deficient on account of the heavy, compact character of the subsoil. No lakes and few areas of Peat or Muck are found within the typical Spencer silt loam areas except to a small extent along some of the stream channels, though marshy tracts border the type in several places.

The material forming the Spencer silt loam is the weathered product of ground-up rock left upon the surface early in the Glacial Period. It has been derived almost entirely from the old igneous rocks which make up the underlying formation throughout this region. It is not probable that any of the soil-forming material has been moved a long distance by glacial action, and the soil has some of

the characteristics of a residual soil. The comparatively small number of stones and bowlders present is due in part, at least, to their disintegration and breaking up into soil during the long period which has elapsed since the old drift formation was deposited. This drift has been eroded and washed by streams and rains for so long a period that depressions and irregularities in the surface have been largely drained or have been filled by wash from adjoining slopes, so that at the present time swamps or peat bogs or lakes seldom occur in this region.

The Spencer silt loam was originally covered with a dense forest growth of hardwoods and hemlock, with a scattering of large white pine. Practically all of the pine has been cut, but there are still extensive tracts of virgin hardwood and hemlock. The hardwood consists of maple, birch, basswood, and elm, with some ash and oak. There are also extensive tracts where all the merchantable timber has been removed and a second growth of poplar and birch has sprung up.

About 15 or 20 per cent of the Spencer silt loam is cleared and under cultivation and agriculture on all except the level phase is well advanced. All crops common to this region are successfully grown. Grasses and clover do especially well and the yields of hay range from $1\frac{1}{2}$ to $2\frac{1}{2}$ tons per acre. Oats are grown as the leading small-grain crop and yield 35 to 50 bushels per acre. Wheat gives about 25 bushels per acre on the average, but the acreage is comparatively small. Some barley and rye are grown and satisfactory yields are obtained. Corn is grown, especially for fodder and ensilage, and some years it matures. Both flint and dent varieties are grown. Potatoes are grown to some extent and frequently on a commercial scale. Ordinary yields are 150 to 200 bushels per acre, though larger returns are common. Sugar beets can be successfully grown, but most of this type of soil lies too far from shipping points for this crop to be profitable.

Where the timber has been removed and the brush cut the type affords excellent grazing and this region as a whole is well adapted to the dairy industry, in conjunction with general farming, which is the chief type of agriculture followed at present. The tendency seems to be toward the more extensive development of dairying.

The crop rotation most commonly followed consists of corn followed by oats, with which clover or clover and timothy are seeded. The oats may be followed by a year of wheat, barley, or rye before the field is seeded. Hay is usually cut for two years, and the field may be pastured for a year before being again plowed for corn. The abundance of uncleared and brush land, however, usually provides sufficient grazing, and so the cultivated fields on many farms are not used for grazing at any time during the rotation. Stable manure is the only fertilizer used, and this is most often applied to sod.

The Spencer silt loam is not so difficult to cultivate as a clay soil, but it is rather heavy and can not be worked under so wide a range of moisture conditions as most of the other types in this survey. If plowed when too wet there is danger of puddling and it is difficult to get a good seed bed. When the moisture conditions are the most favorable, however, little difficulty is experienced. It is best to plow this class of land in the fall, if possible, and to disk and harrow as thoroughly and as frequently in the spring as the weather conditions will permit before the crop is planted.

Cut-over land of this type ranges in price from \$10 to \$25 an acre. Where the brush has been cut and the land is still in stumps, with a good stand of grass, the selling price is about \$20 an acre. Where farms are about half improved, the value ranges from \$40 to \$50 an acre.

Spencer silt loam, level phase.—The level phase of the Spencer silt loam is confined to Ackley Township in the southwestern corner of Langlade County. It represents only a small proportion of the whole type, but it is of sufficient importance to be shown separately on the soil map.

In texture the soil is a silt loam very similar to that of the typical soil as described, but on account of its lower position and naturally poorer drainage there is a somewhat larger supply of organic matter in the surface soil. There are also fewer stones upon the surface. The subsoil is a heavy silt loam, grading into a silty clay loam or clay, in which a blue or drab color is more prominent than in the typical Spencer silt loam. There are probably more small, angular rock fragments in the deep subsoil and the depth to bedrock may average slightly less than on the typical soil, though outcrops of the bedrock are seen only in a few places.

The origin of this phase is doubtless the same as that of the remainder of this type of soil, but the line between this and the Merrimac silt loam, which is an outwash plain type, is a difficult one to locate accurately because of the dense second growth and the practically imperceptible change in topography from one soil to the other. It is probable that some outwash material has been included with the level phase of the Spencer silt loam, but in none of the borings on this phase could beds of sand or gravel be found.

The surface of this phase is so nearly level and the texture of the soil is so heavy that the natural drainage is deficient and the surface water moves off slowly.

The native timber growth is the same as on the typical soil. Most of the merchantable timber has been removed, but none of the land has been cleared. In the improvement of this soil the most important consideration is that of drainage. When drainage has been properly

established the level phase will be equal in producing capacity to the typical soil.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the typical Spencer silt loam:

Mechanical analyses of Spencer silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
311760.....	Soil.....	0.6	2.2	2.5	5.0	6.2	67.4	16.2
311761.....	Subsoil.....	1.5	3.5	5.0	7.2	14.4	57.9	10.7

MIAMI SERIES.

The Miami series is one of the most important of the glacial province. The soils are brown, light brown, or grayish and are underlain by yellowish and brown, heavier textured subsoils. Mottlings of brown and light gray are present in the subsoils in places. Drainage is usually good, but artificial drainage is needed in some of the heavier types. The soils are in the main derived, through weathering, from glacial till of a generally calcareous nature. Some of the gravelly phases, however, are in part at least water assorted, having been deposited as obscurely stratified material in such forms as kames and eskers. The Miami soils are timbered upland types and have considerable range in texture. The Miami soils mapped in the present survey are the fine sandy loam, with one phase, the fine sand, and the loam.

MIAMI FINE SANDY LOAM.

The Miami fine sandy loam is one of the best, most extensive, and most highly developed soil types in the present survey. It appears as an extensive belt of country, including a large part of southern Marinette, southern and southeastern Oconto, and southeastern Shawano Counties. This belt begins at a point about 7 miles south-east of Shawano, in Waukechon Township, Shawano County, and extends in a northeasterly direction for a distance of about 70 miles, reaching as far north as Wausaukee and Packard in Marinette County, and ranging in width from 5 or 6 miles to over 20 miles. Included with the typical Miami fine sandy loam are a number of phases, the most important of which has been indicated separately on the soil map as the poorly drained phase. The entire type, with the poorly drained phase included, covers an area of 452.7 square miles. The towns and stations of Cecil and Greenvalley in Shawano County, Gil-

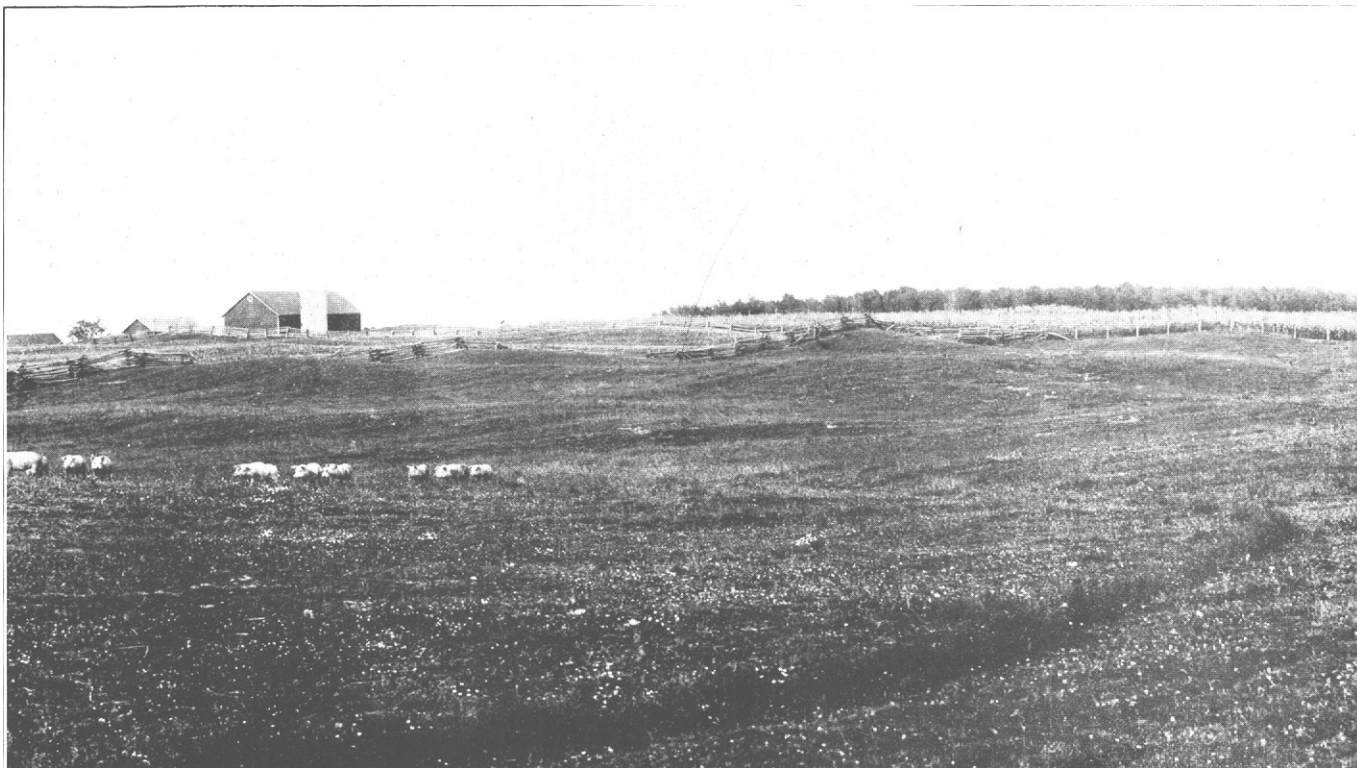
lett, Oconto Falls, Stiles Junction, and Lena in Oconto County, and Beaver, Porterfield, Loomis, Kinsman, and Packard in Marinette County are all situated within the region where this type predominates. Throughout this general area the Miami fine sandy loam occupies extensive unbroken tracts. It is associated with Miami fine sand, Kewaunee fine sandy loam, soils of the Fox series, numerous areas of Muck and Peat, and a number of other soils of minor importance.

The surface soil of the Miami fine sandy loam as typically developed consists of a brown or light-brown, friable fine sandy loam extending to an average depth of 10 to 12 inches. On drying the surface has a grayish appearance, which gradually becomes darker as the moisture content increases. Usually the amount of organic matter present is small, but in depressions where it has accumulated, or where moisture conditions have been favorable for plant growth, the surface soil frequently has a dark-brown color. Immediately below the surface soil there is usually a yellow or yellowish-brown loamy fine sand which extends to a depth of 18 to 20 inches, where it grades into a rather compact, sticky sandy loam or gritty clay loam. This heavy material extends to a depth of 26 to 30 inches, where unsorted glacial till is reached, consisting of yellow or yellowish-brown sand or sandy loam with which is mixed varying amounts of gravel and stones. A small amount of gravel frequently occurs upon the surface, and such material is commonly found all through the 3-foot section, the quantity in the subsoil often being large. The greater proportion of this gravel consists of limestone material, with sandstone and crystalline rock material making up the balance. Stones and boulders are irregularly distributed over this type, and in local areas they are sometimes so numerous as to interfere with cultivation. Most of the stones have been removed from the improved land and used for building purposes, or as fences, or have been disposed of in piles about the farms. A considerable proportion of the boulders are limestone.

There are several variations in this type which were not of sufficient importance to be classed as separate phases, but which may be mentioned briefly. At a number of places, especially in Shawano County where the Miami fine sandy loam borders the Kewaunee fine sandy loam, the surface soil is heavier than typical and frequently contains enough silt to be classed as a loam. The subsoil along the line of contact between these two soils is frequently reddish brown in color, and in places it is heavier than typical and extends to a greater depth. The line between the two types in Shawano County is usually an arbitrary one, and small tracts of one soil have in places been mapped with the other. At Cecil and at various places in Washington and Waukechon Townships in Shawano County a red subsoil can be found. In a few places the lighter colored and lighter textured layer imme-



MIAMI FINE SAND NORTHWEST OF SURING, OCONTO COUNTY, SHOWING TYPICAL SURFACE FEATURES AND PRESENT GROWTH.



KEWAUNEE FINE SANDY LOAM NEAR BONDUEL, SHAWANO COUNTY.

Note the surface features and good state of cultivation.



MERRIMAC SILT LOAM NEAR ANTIGO, LANGLADE COUNTY.

Note the level surface and highly improved farms.



FOX FINE SANDY LOAM EAST OF GILLETT, OCONTO COUNTY.

Note the level topography and highly improved farm. Surface features are typical of all Fox and Plainfield types.

diately below the soil does not appear. Its absence, however, is not invariably confined to the places where the soil or subsoil is heavier than usual. There are a few places throughout the type where gravel beds occur at or near the surface, but never over any extensive area.

The Miami fine sandy loam resembles the Kewaunee fine sandy loam and the Gloucester fine sandy loam in many respects. It differs from the Kewaunee in the color and texture of the subsoil, the latter having a reddish or pinkish-red subsoil, which is usually somewhat heavier than that of the Miami fine sandy loam. The Miami differs from the Gloucester chiefly in containing a large amount of limestone material, while the latter contains none.

The surface of the Miami fine sandy loam varies from gently rolling to rolling, with a few undulating tracts of rather limited extent. The slopes are usually quite long and gentle and upon some of the long slopes there are minor irregularities which tend to give the land a bumpy appearance, but such tracts are of small extent. No steep, abrupt slopes are found, and with few exceptions modern farm machinery can be used over the entire soil type. Because of the lay of the surface and the gravelly nature of the subsoil, the natural drainage is excellent. While the subsoil is sufficiently heavy to retain moisture for growing crops, it is porous enough to permit the excess water from rains to percolate through and drain away. The type seldom suffers from drought to a greater extent than the heavier soil types of the area, except in local areas where gravel or sand deposits are responsible. On a few of the steeper slopes there is slight damage from erosion, but this is not as pronounced as on soils of heavier texture of like topography. In some of the depressions and draws, and bordering tracts of low, wet land, there are places which would be benefited materially by tile drains, though such areas are of very small extent.

The material composing the Miami fine sandy loam has been derived from the weathering of glacial drift which is found here chiefly in the form of an extensive ground moraine. Some of the rougher portions might be classed as recessional moraines, and there are a very few places where kames are found, though covering too small an area to be indicated on the soil map. The greater proportion of the type is found overlying Lower Magnesian, Trenton, and Galena limestone, and the ground-up material from these formations has entered largely into the composition of the soil. The granitic boulders indicate that a portion of the drift must have been transported some distance from the north. The glacial ice carried the calcareous drift beyond the margin of the underlying limestone in places, so that soils of the Miami series are sometimes found over other formations than limestone. In this area the Miami soils are found extending over the Potsdam sandstone formation for a short dis-

tance. Because of the large amount of ground-up limestone and limestone gravel in this type, the subsoil is always highly calcareous. The surface soil, however, has been leached to such an extent that its content of lime carbonate is much smaller than that in the subsoil, and in a few places the soil even gives a slight acid reaction when tested with litmus paper.

The original timber growth consisted of a mixture of pine, hardwood, and hemlock, with the hardwood making up by far the greater proportion. Maple, birch, beech, and hemlock were the most plentiful, though there was a plentiful supply of oak, elm, basswood, ash, and some hickory. Over most of the type there was only a scattering of white pine and some Norway pine, though in a few small areas pine was the predominating growth. Most of the merchantable timber has been removed, though there are still some woodlots which are reserved for fuel. Probably the largest tract of standing timber and unimproved cut-over land is in T. 30 N., R. 19 E., in Oconto County.

A large proportion of the type is in improved farms and probably as much as 60 per cent is under cultivation (see Pl. XXIV). Dairying in conjunction with general farming is the leading type of agriculture followed at the present time, and the tendency is toward a more extensive development of the dairy industry. At present dairying on the Miami fine sandy loam is most extensively developed on the southern areas of the soil in central Oconto and Shawano Counties. Quite a number of hogs are raised, especially on the farms engaged chiefly in dairying, and some beef cattle are raised, though feeding stock for the market has not been developed to prominence.

The crops grown and the yields obtained on this type of soil are: Oats 30 to 45 bushels, barley 20 to 30 bushels, corn 35 to 50 bushels, peas 25 to 30 bushels, potatoes 125 to 200 bushels, and hay $1\frac{1}{2}$ to $2\frac{1}{2}$ tons per acre. Some sugar beets are grown and the yields range from 10 to 12 tons per acre. The quality of the grain grown on this type is very good. Wheat was grown to some extent a number of years ago, but has been largely abandoned. Peas are grown for canning as well as for seed, and the crop usually affords a profit. Potatoes are the most important cash crop and tubers of high quality are produced. Early varieties of corn will mature on practically all portions of the type, though early frosts frequently do some damage. Much of the corn is cut for silage. Alfalfa can be successfully grown on this soil and some farmers have thrifty fields, though the aggregate acreage is small.

More apples are grown on this soil than on any of the other types in the area and the fruit is of high quality. The soil is rich in lime, the subsoil is sufficiently open and porous to permit good root development, and the climate is such as to stimulate a vigorous, sturdy

growth of wood. The rolling character of the surface affords a large number of good orchard sites, and while fruit growing is not extensively developed at present, there are a number of commercial orchards, the success of which indicates that apple culture could profitably be extended to considerable proportions on this type of soil. The varieties most commonly grown here are the Northwestern Greening, Wealthy, Grimes, Snow, Red Astrachan, and Duchess. Some small fruits, such as strawberries and raspberries, are grown and do very well, but they are not produced on an extensive scale.

The question of crop rotations best suited to this soil is being considered by the leading farmers, and while comparative tests have not been made on individual farms, various rotations have been tried in the different communities. The rotation most commonly followed consists of corn or potatoes, followed by a grain crop consisting of oats, barley, or rye, usually oats. Clover or a mixture of clover and timothy is seeded with the grain and hay is cut for two years, after which the field may be pastured a year before again being plowed for corn. The stable manure is most often applied to sod that is to be plowed under for corn. Where special crops such as peas or sugar beets are grown the rotation is varied, and at no time is any particular rotation adhered to closely.

The Miami fine sandy loam is a comparatively easy soil to cultivate, and a mellow, friable seed bed can be prepared with a minimum amount of labor. Cultural operations can be carried on under a wide range of moisture conditions. Fall plowing is practiced to quite an extent, and while this is desirable it is not as important on this type as on soils of heavier texture. Practically the only fertilizer applied is stable manure. The practice of green manuring is not common, though there are a few farmers who occasionally plow under some clover or rye. Commercial fertilizers are not used at the present time.

On the whole the methods of farming followed on the Miami fine sandy loam are fairly good, and they are gradually improving. More silos are being built each year. With the extension of dairying there is a decrease in grain production and a gradual improvement in the productiveness of the soil.

Land values on the Miami fine sandy loam are comparatively high. Where farms are well improved and well located the selling price varies from \$50 to \$100 an acre. The wild, cut-over land of this type sells for \$15 to \$25 an acre, depending upon the location.

Miami fine sandy loam, poorly drained phase.—The poorly drained phase of the Miami fine sandy loam is of comparatively small extent and is confined chiefly to Green Valley Township in Shawano County and to scattered areas in Oconto County, chiefly in Morgan, Oconto Falls, Gillett, and Stiles Townships.

This phase represents those portions of the Miami fine sandy loam which are deficient in drainage throughout most of their extent. The surface soil to a depth of 10 to 12 inches consists of a yellowish to grayish-brown, rather heavy fine sandy loam. This material rests upon a brown, compact sandy clay which shows much mottling with gray and yellow. This heavy material may extend to a depth of over 36 inches, becoming more mottled with depth, or it may change gradually below 20 to 26 inches to a grayish-yellow or gray sticky sand containing considerable gravel. Over the lowest portions of the type there is sometimes a shallow covering of muck and peat, but such areas are of very small extent. Where there is no muck or peat the surface soil is heavier than typical. Some stones and boulders are found on the surface.

The surface of the poorly drained phase varies from flat to undulating, with low ridges and marshy tracts so closely associated and occurring in such small areas that a separation could not be made between the low, wet land and the higher lying soil in a general survey of this kind. Most of the tracts are so situated that open ditches and tile drains could be readily installed and the land thoroughly drained.

This phase has the same origin as the typical soil, and while the level portions appear somewhat like outwash material, no stratification is apparent in the subsoil.

The original timber growth was about the same as on the typical soil, but included a larger proportion of elm and ash, and in the wettest places there was, in addition, some tamarack and cedar.

Only a very small proportion of this phase is improved, and where included in farms it is used chiefly for pasture or as hay land. Most of it is utilized in connection with better drained land, and in this way it can be made of considerable value. When the poorly drained phase is thoroughly drained, it will doubtless be very nearly equal in producing power to the typical Miami fine sandy loam.

MIAMI LOAM.

The Miami loam is confined chiefly to Little River, Lena, Oconto, and northern Stiles Townships in Oconto County, where it is the predominating soil. This same general tract extends north into southern Marinette County, where it is also quite extensively developed. Smaller tracts are also found to the southwest of Oconto Falls, in Morgan Township, Oconto County.

The surface soil of the Miami loam to an average depth of 10 to 12 inches consists of a brown or grayish-brown loam. The surface soil rests upon a layer of lighter colored fine sand or fine sandy loam, which extends to a depth of 16 to 18 inches, where a brown or reddish-brown compact silty loam to clay loam, carrying limestone gravel

and rock fragments, is encountered. This heavy material may extend to over 36 inches, though usually at 30 to 34 inches a yellowish fine sand containing a large amount of gravel and rock fragments is reached. In localities where the lighter material immediately below the soil is lacking the type frequently approaches a silty loam in texture. Below 30 inches a red clay is encountered in a few instances, and here the soil approaches the Kewaunee fine sandy loam. There is usually a sprinkling of gravel over the surface of this soil and stones and bowlders are usually plentiful upon the surface. A large proportion of the gravel, stones, and bowlders are of limestone. The underlying limestone rock frequently comes close to the surface, and some of the outcrops of importance are indicated on the soil map. From the cultivated fields many of the stones and bowlders have been removed, and stone piles and stone fences are common sights. It is estimated that over areas of average stoniness there are from 25 to 30 stones per acre over 1 foot in diameter and probably ten times as many of smaller sizes. While stones are common, there are areas of considerable size that are practically stone free.

The surface of this type varies from undulating to very gently rolling. The slope is usually sufficient to provide ample surface drainage, though the subsoil is sometimes sufficiently heavy to retard internal drainage, so that over the lower portions of the type and on a number of the gentle slopes tile drains could be installed to advantage. The soil retains moisture very well, and crops seldom suffer from drought except during the most severe dry periods.

The material forming the Miami loam is derived from the calcareous glacial drift which covers the southeastern portion of the present survey.

The original timber growth was a mixture of pine, hardwood, and hemlock, the greater proportion being hardwood.

A large proportion of this type is under cultivation. Very little timber is standing. The type ranks as one of the best and most productive soils in the area surveyed. The crops grown are the same as on the Miami fine sandy loam, but the average yields frequently run a little higher. The acreage of potatoes is somewhat lower than on the fine sandy loam, because of the heavier texture of the loam. The same methods of farming are followed and the same rotations practiced as on the Miami fine sandy loam, though the dairy industry appears to be somewhat more highly developed. This is probably due to the fact that this type has been under cultivation longer than many others of the area. The soil is more difficult to cultivate than the Miami fine sandy loam, it can not be worked under as wide a range of moisture conditions, and it does not warm up quite as early in the spring; also a larger proportion is in need of drainage.

The selling price of land of this type, where the farms are well improved, ranges from \$50 to \$100 an acre. There is only a small extent of unimproved land of this type in the present survey.

MIAMI FINE SAND.

The Miami fine sand is quite widely distributed throughout the southern part of Oconto County, where it is closely associated with the Miami fine sandy loam. There is a tract of about 15 square miles in Little Suamico Township, and between Stiles Junction and Morgan there is another of nearly the same extent. A few small areas are found in Shawano County, mostly in Green Valley Township.

The surface soil of the Miami fine sand consists of a yellowish-brown or grayish-brown fine sand extending to an average depth of 8 inches. There is a very small quantity of organic matter in the surface 2 or 3 inches of virgin soil, but after cultivation for a few years most of this is lost. The subsoil consists of a yellow, loose, incoherent fine sand. This becomes slightly lighter in color and somewhat coarser in texture with depth, until in the lower portion of the subsoil the material is a pale-yellow medium sand with some fine gravel in places. While a few stones may occur on the surface, they are not common.

A variation from the typical soil which was included with it in mapping is represented by long, narrow, winding ridges or eskers, which are locally known as "hogbacks." On these ridges both soil and subsoil are often quite gravelly, and most of the gravel is limestone.

The Miami fine sand corresponds very closely to the Coloma fine sand, which is found in the sandstone regions, and to the Gloucester fine sand, which occurs over crystalline rocks, and it has practically the same texture, structure, and topography as these types, but it differs from them in that it has been derived from calcareous glacial till. While the type as a whole is in an acid condition and contains very little lime carbonate, it is closely associated with other types of the Miami series which are not acid, or only slightly so at the surface, and which contain large amounts of lime carbonate in the subsoil.

The surface of the Miami fine sand varies from undulating to gently rolling (see Pl. XXV). In a number of places sand dunes have been formed, and where the cultivated fields are not kept covered with a growing crop the surface soil dries out quickly and is readily shifted by the wind. Growing crops are frequently damaged to a considerable extent by blowing sand. The tract of fine sand immediately to the southwest of Oconto is more nearly level than other portions of the Miami fine sand and is for this reason referred to as a level phase, but the surface even here is rather undulating, with a number of sand dunes in various places which impart a gently rolling surface.

Owing to the topography and the loose, open character of both soil and subsoil, the natural surface and internal drainage is excessive and the type is droughty for a considerable part of nearly every growing season.

The Miami fine sand has been derived from the weathering of the glacial drift which covers this region. The material rests upon a limestone formation and the drift originally contained considerable carbonate of lime, but because of the sandy character of the material a large proportion of the lime carbonate has been leached out and at present both soil and subsoil are to some extent in an acid condition. Where the type occurs as long, narrow ridges it can be classed as eskers, which were deposited by water beneath the glacial ice sheet. Most of the other irregularities of the surface are due to wind action and are sand dunes.

The native timber growth consisted of Norway and white pine, with a smaller percentage of jack pine, scrub oak, white birch, and poplar. Sweet fern grows in profusion over all uncultivated portions of the type.

Probably about 20 per cent of the Miami fine sand is under cultivation at present. The soil is of low agricultural value, and returns from farms of this type are small. General farming is the kind of agriculture followed by most of the farmers on this soil, and the crops most commonly grown are potatoes, corn, rye, beans, hay, and oats. Potatoes constitute the leading cash crop and under the most favorable conditions yield 100 to 150 bushels per acre. Rye is grown more extensively than any other grain and yields average about 15 bushels. Corn usually matures and 25 bushels an acre is considered a fair crop. Oats do not yield well and the acreage is small. Some buckwheat is grown and 12 bushels per acre is an average return. The yields of hay are small, as is the amount of pasturage afforded after the hay crop is removed. The wild land of this type provides some pasturage, especially in the spring and early summer, but later in the season the grass dries up.

Wherever a leguminous crop, such as clover, has been introduced and organic matter added to the soil, yields higher than those mentioned are obtained. The practice of green manuring is not common, and the methods generally followed are not such as tend to maintain the soil fertility.

Farms on this type having fairly good improvements sell at about \$50 an acre. Wild land sells for \$15 to \$30 an acre, depending upon the location.

SUPERIOR SERIES.

The surface soils of the Superior series are gray, brown, or reddish, with pinkish-red to light chocolate red, rather dense clay subsoils. The series comprises a group of glacial-lake soils developed prin-

cipally along the margin of Lake Superior, but found to a lesser extent along the western shore of Lake Michigan and in central Wisconsin and Minnesota. The topography is usually level to only slightly undulating, though erosion produces sharp V-shaped gullies and stream valleys. Stratification is usually apparent in the deep subsoils, which are calcareous. The types mapped under this series in this reconnoissance are the fine sandy loam and fine sand.

SUPERIOR FINE SANDY LOAM.

The Superior fine sandy loam occupies a total area of 42.3 square miles and is found in three of the six counties covered by the present survey. The largest occurrence is in southeastern Shawano County in Navarino, Angelica, and Maple Grove Townships. In Oconto County there is another quite extensive irregular tract of about 14 square miles, chiefly in Chase Township. In Marinette County there are several small patches about 2 miles south of Dunbar, but their combined area is not more than 1 square mile.

The surface soil of the Superior fine sandy loam to an average depth of 10 inches consists of a light-brown to dark-brown fine sandy loam, which frequently contains a large percentage of very fine sand and varying amounts of organic matter, though the supply is usually small. The subsoil consists of a fine or very fine sandy loam or fine sand of a yellowish color, which may become gray in some of the poorly drained places. This material extends to a depth ranging from 20 to 30 inches, where a heavy, stiff red clay is encountered. Lenses of fine sand are sometimes found in the heavy clay and in a few instances the sand has become mixed with the clay. The depth of this bed of red clay is quite variable. It may not be encountered until a depth of 36 inches is reached, or it may occur within 10 inches of the surface and even outcrop frequently. In some places the surface soil is a loam or clay loam, while in other places it is so shallow that the underlying clay will be turned up by the plow under cultivation. Such variations, however, are all of too small extent to be indicated on a reconnoissance soil map. The surface is free from stones and boulders, but a few gravel stones may occur scattered through the heavy clay subsoil. The red clay is of a calcareous nature, but an acid condition has developed in the surface soil in places. The Superior fine sandy loam is very similar to the Kewaunee fine sandy loam in texture, but differs from it in topography.

The surface of this type of soil is level or only very gently undulating, and on account of this and the heavy character of the subsoil the natural drainage is frequently defective. The type usually occupies a rather low position, and in a number of instances the water table is too close to the surface to permit the successful growing of

ordinary farm crops without the installation of drainage systems. Open ditches have been constructed in some localities, but very few tile drains have been installed.

The heavy material composing the subsoil of the Superior fine sandy loam is undoubtedly of lacustrine origin, having been laid down in quiet waters, probably during an interglacial period. In a few places excavations present a laminated structure, indicating that in these particular places at least the material has not been modified to any extent since its original deposition. The surface soil was probably deposited over the clay during the last period of glaciation. The differences in depth to the clay may be due to erosion which took place before the sandy covering was deposited.

The original timber growth consisted of maple and birch, with some hemlock and elm and a scattering of white and Norway pine. Most of the merchantable timber has been cut and a second growth of birch and poplar covers the ground in a number of places where no improvements have been made.

Probably 50 per cent of this type of soil is cleared and under cultivation at present. Dairying in conjunction with general farming is the chief type of agriculture followed. In Navarino Township, in Shawano County, there is a thrifty, prosperous farming community developed on this soil. The chief crops grown are corn, oats, and clover and timothy hay. Some barley, potatoes, and a little wheat are also produced and the average yields of all of these crops where fields are sufficiently drained are about equal to the yields on the Miami fine sandy loam and other like-textured soils. The soil is not difficult to cultivate except in a few places where the clay subsoil comes near the surface or is exposed. Where the drainage is deficient the type is rather "late" in the spring.

Farms on this type of soil are valued at \$75 an acre and even higher where well located and especially well improved. Uncleared tracts range in value from \$20 an acre up.

SUPERIOR FINE SAND.

The Superior fine sand is of small extent in the present survey, occupying a total area of only 13.6 square miles. The larger part of this total is found in the southern part of Navarino Township and the southwestern part of Lessor Township in Shawano County. A small area occurs about 1 mile southwest of Krakow. In Chase Township, in Oconto County, there is also about a square mile of this soil. The type is associated chiefly with the Superior fine sandy loam and the soils of the Kewaunee series.

The surface soil of the Superior fine sand to an average depth of 10 inches consists of a light-brown to slightly yellowish brown fine sand which contains only a small amount of organic matter in the

surface inch or two. The subsoil is a yellow or yellowish-brown fine sand which extends to a depth of 24 to 30 inches, where the sand usually has a pinkish cast. At a depth of 36 to 48 inches heavy red clay may be encountered, though the depth to the clay, if present, is variable. It is found within reach of a 3-foot auger at a number of points throughout the areas mapped, and it is probable that the bed of clay is continuous.

In a number of places there are small sand dunes on this type, though wherever these are of sufficient size they are indicated on the map as Coloma fine sand. They usually occur where the depth to clay is greatest and the surface dries out most thoroughly.

The surface of the Superior fine sand is level. The heavy clay underlying this type has a tendency to keep the water table high and there are times in the spring when the soil is so wet as to retard crop growth somewhat. Later in the season, however, the bed of clay is beneficial, as it acts as a reservoir and keeps a supply of moisture available for growing crops for a much longer period than a more pervious substratum. There are a few places where open ditches or tile drains could be installed to advantage, though over much of the type fairly good yields are possible without artificial drainage.

The heavy red clay underlying this soil is doubtless of lacustrine origin, having been deposited in quiet water, probably during an interglacial period, when Lake Michigan covered a much larger area than at present. It is largely confined to the Wolf River valley and lies lower than most of the surrounding land. The sandy covering was probably deposited during the last invasion of the ice sheet when large quantities of water were issuing from the ice and when all streams were greatly swollen, or it may have been washed down from the higher land adjoining after the retreat of the last ice sheet. The heavy red clay is quite calcareous, but the sandy covering is usually in an acid condition.

The original timber growth consisted chiefly of white and Norway pine, all of which has been cut. There is now a second growth consisting of poplar, birch, hazel bushes, and, in the wettest places, of willow.

Only a very small proportion of this soil is under cultivation at the present time, the greater part of it having been abandoned after the timber was removed. Where farms have been started fair results are being obtained and corn, grass, and small grains produced successfully. The type is probably better adapted to truck growing than to general farming, but on the whole the distance from shipping points tends to discourage the development of trucking. A proposed extension of the Wisconsin Northern Railroad would largely remove this impediment to marketing.

KEWAUNEE SERIES.

The Kewaunee series is developed most extensively in the region of Lakes Michigan and Superior and is characterized by grayish to reddish-brown or pinkish soils overlying pinkish-red silty clay and rather calcareous subsoils. Like other soils derived from till, the 3-foot section contains more or less subangular gravel, stones, and boulders. The material resembles that of the Superior series, and, like it, was chiefly laid down originally as glacial-lake deposits, but it has been reworked by subsequent glacial action and mixed with more or less stony material, so that it has the appearance and some of the characteristics of glacial till. The topography varies from undulating ground moraine to hilly terminal moraine and the soils are subject to more or less erosion. The soils of this series are most extensively represented by the heavier members. The types mapped in the present survey are the fine sandy loam, loam, and clay loam.

KEWAUNEE FINE SANDY LOAM.

The Kewaunee fine sandy loam is one of the important soil types in the area surveyed from the standpoints of acreage and stage of agricultural development. It is confined to Shawano, Florence, and Oconto Counties and comprises a total area equivalent to more than four townships. Two separate tracts are found in Shawano County, the first being directly southwest and west of Shawano, chiefly in Richmond and Belle Plaine Townships, and the second in the southeastern corner of the county in Hartland, Angelica, Lessor, and Maple Grove Townships. This last-named tract is the largest unbroken area mapped, and from an agricultural standpoint it forms one of the best developed districts in the entire survey. In Oconto County the Kewaunee fine sandy loam is confined mainly to the vicinity of Suring, chiefly in Howe, Maple Valley, and Underhill Townships. This area is more irregular than the others mentioned and is associated with a number of smaller neighboring tracts. In Florence County there is only a small tract of about $3\frac{1}{2}$ square miles, found 3 miles south of Florence.

Under normal moisture conditions the surface soil of the Kewaunee fine sandy loam to an average depth of 10 inches consists of a grayish-brown to brown fine sandy loam, underlain by a yellowish-brown fine sandy loam somewhat lighter in texture and color than the surface material. This lighter stratum usually extends to a depth of 16 to 20 inches, where it changes abruptly into a heavy, compact, pinkish-red gritty clay loam or clay. There are present upon the surface and mixed with the soil varying quantities of gravel, and frequently boulders are found, the largest about 3 feet in diameter. Taking the type as a whole, however, the stones are not so abundant as to lower the agricultural value of the soil. Over the portions of

the type in Florence County and central Shawano County the gravel and stones are chiefly granitic. In Oconto County there is considerable limestone gravel and some limestone boulders. In southeastern Shawano County the underlying rock and fully 95 per cent of the gravel mixed with the soil is limestone.

There are a number of notable variations in the type. In places the depth to the underlying clay is greater than usual, the clay sometimes being below the reach of the 3-foot auger. While the surface soil in such situations still remains a fine sandy loam, it is as a very light phase of that type. This variation is confined to the areas found in Oconto County. On the other hand, there are small tracts where the clay appears closer to the surface than usual, and in some localities the surface covering has been entirely removed and the heavy clay exposed. Such tracts are found in Oconto County, but probably to the largest extent in Shawano County. Both of the variations mentioned cover such small areas that in a general survey they could not be indicated on the soil map.

The extensive area of Kewaunee fine sandy loam in southeastern Shawano County differs somewhat from typical. The lighter colored material immediately below the surface soil is very often lacking, or much thinner than usual, and the heavy underlying clay thus comes closer to the surface than over the remainder of the type. The surface soil is also frequently heavier than typical and may be described as a heavy fine sandy loam which in places grades into a loam or silt loam. This whole tract may, therefore, be considered as a heavy phase of the Kewaunee fine sandy loam. In a detailed survey, in addition to the fine sandy loam, a loam and clay loam or silt loam could probably be recognized in this tract, but in this general survey it is impracticable to map separately variations of such small extent.

The Kewaunee fine sandy loam is largely associated with the Miami fine sandy loam in Oconto and in southeastern Shawano Counties. The line between these two types is not always sharply drawn because the transition from one to the other is frequently gradual. Small areas of Miami fine sandy loam are, therefore, in places, included with the Kewaunee. In the large tract to the southwest of Shawano the Kewaunee fine sandy loam is associated with the Coloma fine sandy loam to a considerable extent and may here include small tracts of the Coloma type.

The Kewaunee fine sandy loam resembles both the Coloma and Miami fine sandy loams in the texture of the surface soil, but the subsoil of the Kewaunee is heavier and has a red color in place of a brown or yellowish brown.

The surface of the Kewaunee fine sandy loam varies from undulating to gently rolling and rolling, though the amount of undulating land is comparatively small. A portion of this soil in Oconto County

has long, gentle slopes from relatively broad ridge tops, and upon these slopes there is frequently superimposed a series of low mounds, which impart a rather hummocky appearance. In Shawano County there is more variation in the surface and in a few places it is hilly. The range in elevation from the highest hilltops to the bottom of the intervening valleys probably exceeds 250 feet. The slopes, however, are nowhere too steep to be cultivated, and practically all of the type is highly improved. A few potholes occur on this soil, but even in such places there is very little waste land.

On account of the uneven topography the natural surface drainage is good over most of the type. The subsoil is frequently quite heavy and compact, however, and the internal drainage is often somewhat deficient. In a number of the depressions between slopes, over the more nearly level portions of the type, and even on some of the gentle slopes, tile drains could be installed to advantage.

The material composing the subsoil of the Kewaunee fine sandy loam was originally laid down as a lacustrine deposit, more or less near the region where it now lies. After its original deposition it seems to have been greatly modified by glacial action. The advance and retreat of the ice sheet not only reworked the lacustrine material, but also ground up the underlying rock and mixed it with the material from which the soil has been derived. Thus there is now a large amount of limestone mixed with this red material in the limestone region, and a considerable amount of granite where the glacier traversed the regions underlain by this class of rock. The lighter colored surface soil of the Kewaunee fine sandy loam and the lighter colored spots in the subsoil were in part derived from the grinding up of the underlying rock formations by the ice, and in part by the transporting of light-colored material which had doubtless been acted upon by an earlier glacial invasion. The surface of the lacustrine material may also have been sufficiently leached to account in part for the lighter color at the surface. Wind action also probably added considerable material to the surface at a time when there was little vegetation to hold the material in place.

The heavy red subsoil of this type is of a calcareous nature and contains a large amount of lime carbonate, especially throughout the region underlain by limestone rock. The surface soil has been leached to some extent and a slight acid condition developed in places. This is most pronounced in the regions underlain by granitic and sandstone rocks.

The original timber growth consisted of maple, elm, beech, basswood, hickory, and birch, with some hemlock, and white and Norway pine. Most of the merchantable timber has been cut, but there are still a considerable number of farm woodlots from which the farmers get firewood and some building material.

The Kewaunee fine sandy loam is highly improved and probably over 75 per cent of it is under cultivation (see Pl. XXVI). It is the best and most highly improved extensive soil in the area surveyed. The type of agriculture most commonly practiced is general farming, with dairying as the most important branch. The tendency at present is toward more extensive dairying. Silos are in quite common use, and the number is added to each year.

The common crops grown and yields obtained are: Oats, 30 to 50 bushels; timothy and clover hay, 1 to 2½ tons, and corn, 40 to 60 bushels per acre. While corn can be matured nearly every year, except in the most northerly areas of the type in Florence County, and while even here it matures during most seasons, the crop is grown mostly for silage, of which an excellent quality is produced. Potatoes are grown on a commercial scale in a few localities and yields of 200 to 250 bushels per acre are not uncommon. The light phase of the type is better adapted to potato growing than the heavy phase. Peas are grown both for seed and canning purposes, though mostly for seed, and yield 20 to 25 bushels per acre. Sugar beets are grown to a small extent and produce 12 to 15 tons per acre. Alfalfa is grown in a small way, with ordinary yields of about 3 tons per acre. Much interest is being taken in this crop and the acreage is increasing each year. The soil, together with other factors, is well adapted to alfalfa. Wheat is still grown by a number of farmers, and as a rule the yields are profitable, ranging from 20 to 30 bushels per acre. Barley and rye are also produced, but not extensively.

The rotation of crops most usually followed consists of corn followed by oats, which may be followed by oats a second year, or by wheat, barley, or rye. If a grain does not follow the oats, the field is seeded and hay is cut the two following years with possibly one year additional of pasturing before the field is again plowed for corn. The stable manure is usually applied to sod to be plowed for corn. Manure spreaders are in quite common use and the supply of manure is utilized economically.

The Kewaunee fine sandy loam is somewhat more difficult to handle than either the Miami or Coloma fine sandy loams, because the surface soil is a little heavier and the depth to the underlying clay is less. Frequently the heavy clay is turned up with the plow, but it is seldom that any difficulty is experienced in getting a good mellow seed bed. This soil is easier to handle than the Kewaunee loam or clay loam.

Agriculture on this type of soil is well developed. The farms are well cultivated as a rule, the buildings are substantial and kept in good repair, and the conditions over the type as a whole indicate thrifty and prosperous circumstances. The extensive tract in southeastern Shawano County is particularly highly developed.

Improved, well-located farms on the Kewaunee fine sandy loam in southeastern Shawano County range in value from \$75 to \$100 or even more an acre. The average value is probably somewhat less in Oconto County, as a smaller proportion of the type there is highly improved. In Florence County the selling price is still lower, as there is less development than elsewhere, although the quality of the soil is equal to that in other places. Unimproved cut-over land sells for \$20 to \$40 an acre, though the extent of such land now available is small.

KEWAUNEE LOAM.

The Kewaunee loam is found only to a small extent in the present survey and may be considered one of the unimportant types. It has a total area of 11.8 square miles. The largest tract, of about 7 square miles, is located in eastern Florence County about 9 miles south of Florence, in Homestead Township. The remainder of the type occurs in several small patches about 6 miles southwest of Suring, in Oconto County.

The surface soil of the Kewaunee loam to an average depth of 10 to 12 inches consists of a very fine sandy loam of a gray to yellowish-gray color. The subsoil to a depth of 36 inches or more consists of a heavy, stiff, compact pinkish-red clay. Well records indicate that this clay extends to a depth of 80 feet in some places. The surface soil is quite variable in depth and frequently extends to 18 inches, but in certain localities the underlying clay outcrops over areas too small to be shown in a general survey. A few stones and bowlders are found upon the surface, but never in sufficient numbers to interfere with tillage. Some small gravel stones are also present upon the surface and mixed with both soil and subsoil.

The surface of the Kewaunee loam varies from undulating to very gently rolling, with a few small tracts that are nearly level. As a type the natural surface drainage is fairly good, but the subsoil is so heavy and compact that the internal drainage is deficient and water moves through the soil section very sluggishly. The rougher portions of the type occur adjacent to the stream courses where erosion has been the most active.

The heavy red clay subsoil is doubtless of lacustrine origin, but since its original deposition it has been modified more or less by glacial action, weathering, and erosion. The sandy or loamy covering is probably of more recent deposit than the clay itself and may have been carried by a later ice sheet which advanced after the clay had been laid down. The stones and bowlders owe their presence to the glacial ice sheet. The varying depths of the surface soil may be accounted for by the erosion which took place on the clay before the present surface material was deposited. While the red

clay is somewhat calcareous, there is no limestone present, except a very small amount in the area in Oconto County. Most of the gravel, stones, and boulders are granitic. The surface soil is acid in places, especially where the surface material is deep.

The original timber growth consisted chiefly of maple, birch, and elm, with some white and a little Norway pine. Practically all of the merchantable timber has been cut and where the land is not cleared and improved a dense second growth has sprung up.

Probably over 40 per cent of the Kewaunee loam is cleared and under cultivation. The area in Florence County is a little too far north for corn to mature with certainty, although on all of the type corn for silage can readily be grown, and some seasons it can be matured. Oats, barley, wheat, and hay are well suited to this soil and give good yields. It is well adapted to general farming and dairying. The farming communities on this soil are comparatively new and definite systems of cultivation and crop rotation have not been carefully worked out. On the parts of the type where the drainage is the most deficient hay is grown more extensively than any other crop and some of the land is used for pasture. Considerable grazing is afforded throughout the cut-over tracts, as there is a dense growth of clover, timothy, and June grass along all the old logging roads and grass is usually plentiful through the slashings.

Where the surface covering is shallow the type requires more careful management and is more difficult to cultivate than where the surface soil is deep. Drainage of the low places and careful tillage are the two most important factors in the handling of the Kewaunee loam.

KEWAUNEE CLAY LOAM.

The Kewaunee clay loam is of small extent and occupies only 12.7 square miles in the whole area. It is confined to southeastern Shawano County, mostly in Maple Grove Township, and to Maple Valley and Spruce Townships in Oconto County. The tracts are seldom over 1 square mile in extent and are quite widely scattered. The soil is associated with the Kewaunee fine sandy loam, and in places with the Superior and Miami soils.

The surface soil of the Kewaunee clay loam to an average depth of 8 inches consists of a dark-gray or dark reddish brown silty clay loam containing only a comparatively small amount of organic matter. The subsoil consists of a heavy, compact, pinkish-red clay or silty clay loam which extends to a depth of over 3 feet. Very little gravel is found upon the surface or mixed with the soil, and only a very few boulders are found. The type varies somewhat, chiefly in the surface soil. This may be gray silt loam or a grayish-yellow fine to very fine sandy loam on some of the higher elevations. In some of the lower lying places there is more organic matter present and the

surface is dark gray or almost black. Such variations, however, are of too limited extent to be indicated in a general survey. The type as a whole resembles the Kewaunee loam, but differs in its heavier surface soil and smaller gravel content.

The surface varies from gently undulating to gently rolling, and there is sufficient slope over the type as a whole to afford fairly good surface drainage. The soil is so heavy and compact, however, that the internal drainage is poor, and water moves through the soil section very slowly. The lower lying portions of the soil are in need of tile drainage, and even gentle slopes would be benefited by this improvement.

The Kewaunee clay loam is most probably derived from reworked glacial-lake material. It seems probable that the advance and retreat of the ice sheet moved this material only a very short distance and that the action was one of a slight mixing rather than a transporting of the material. The material composing the surface soil of the Kewaunee clay loam is of a calcareous nature, and only in a very few instances has the surface been sufficiently leached to permit the development of an acid condition.

The original timber growth consisted chiefly of large white pine, with some maple, hickory, elm, and basswood. All of the timber has been removed and practically all of the type is now under cultivation.

The Kewaunee clay loam is considered a good general farming soil, and in this area it is devoted to the production of timothy, clover, and small grains, including oats, barley, and wheat. Some corn is also grown and sugar beets and peas are two special crops grown to a limited extent. The heavy character of the soil makes it somewhat backward, but it produces good yields under proper conditions of moisture and cultivation. The type is the most difficult soil in the area to cultivate, and there is danger of puddling and baking if it is plowed when too wet. When worked at the proper time a fairly good seed bed can be worked up with comparatively little difficulty.

MERRIMAC SERIES.

The surface soils of the Merrimac series are brown to light brown in color and are usually underlain by yellowish sand and gravel. This series is found extensively in eastern New York and the New England States and constitutes the high glacial terraces which occur along nearly all the streams of this section. In Wisconsin it occurs as numerous outwash plains. The material consists principally of the decomposition products of crystalline rocks, reworked by water, and deposited during the close of the Glacial period. From their composition and structure they are usually leachy soils, especially the coarser textured members. The types mapped in this survey are the silt loam, sandy loam, and fine sandy loam.

MERRIMAC SILT LOAM.

The Merrimac silt loam is the most extensive type of the Merrimac series in the area surveyed, and it may be classed with the more important soil types of the area from the standpoint of productiveness as well as of extent of agricultural development. The most extensive tract is found in the southwestern part of Langlade County, where there is an unbroken area covering approximately 150 square miles. Antigo, Deerbrook, Bryant, and Ormsby are located upon this tract. Numerous other tracts of this soil, though of much smaller extent, are scattered throughout the northwestern half of the area, and in many instances such tracts have been selected as town sites. Crandon, Laona, Blackwell, and Wabeno in Forest County, Elcho in Langlade County, and Birnamwood, Eland, and Tigerton in Shawano County are among the towns situated wholly or in part upon areas of Merrimac silt loam.

The surface soil of the Merrimac silt loam where typically developed consists of a light-brown or grayish-brown, friable silt loam which extends to an average depth of 12 inches. The content of silt is usually high, giving the material a smooth feel. The quantity of organic matter present is comparatively small, and the soil as a whole is in an acid condition. The subsoil consists of a yellowish-brown silt loam which gradually becomes heavier and grades into a silty clay loam. At an average depth of 22 to 30 inches the material grades abruptly into beds of stratified sand and gravel. The depth to the sand and gravel is variable, however, and differences of 1 foot to 4 feet may occur within a distance of a few rods. At a brickyard west of Antigo the silt covering is over 5 feet deep, while at other places not far distant, and especially to the east of Antigo, the gravel and sand are sometimes within reach of the plow. In general, it may be said that to the east of Antigo the type is somewhat lighter in texture than it is to the west. There is frequently a sprinkling of gravel upon the surface and a few stones ranging in diameter from 4 to 8 inches may also occur, though over areas where the silt loam is best developed little gravel and few stones are found.

While the greater part of the material mapped as Merrimac silt loam conforms to the above description, this soil is not uniformly developed throughout its extent, but comprises a combination of several phases of small extent so closely associated that in a general survey of this character they could not be indicated separately on the soil map. The surface material varies from a silt loam to a fine sandy loam. Gravel most commonly occurs with the lighter textured phases, and stones are more common in the same general region, though there are extensive areas where no gravel or stones are to be found. The tract upon which Crandon, in Forest County, is located is extremely variable and ranges from a typical silt loam to a sandy loam.

Gravel and a few stones are found on this tract. Some of the areas in Shawano County which are of rather small extent have bowlders upon the surface ranging in diameter from 10 to 18 inches. These are seldom very numerous, probably nowhere being more abundant than 10 or 12 to the acre, except in several areas of a few square rods. There is a small area about 2 miles north of Ormsby, in Langlade County, where the stones are so thickly embedded in the soil that it is impossible to bore with the soil auger, but such tracts are of too little importance to be given more than slight consideration. It may be said in general that the stones are most plentiful around the margins of the silt loam areas. Considering all of the variations which occur, it is probable that in a detailed survey small areas of sandy loam, fine sandy loam, loam, and gravelly loam could be recognized and indicated on the soil map over the tracts now included with the silt loam.

The surface of this soil varies from level to very gently undulating, usually having a very gentle slope toward the water course along which it occurs (see Pl. XXVII). The streams traversing these areas have cut channels 5 to 20 feet below the general level of the adjacent land. The flood plain along such streams varies from a few rods to one-fourth mile in width. The extensive tract about Antigo, in Langlade County, is a prairielike plain in which the differences in elevation do not appear to exceed 6 or 10 feet in a distance of several miles. There is a very gentle slope toward the southwest. Some of the smaller tracts have a more undulating surface than the "Antigo Flat," but none of these could be classed as rough or very gently rolling.

While the surface of the greater part of the type is level, the underlying gravel and sand come close enough to the surface in most places to afford good drainage. Where these beds are 3 feet or more below the surface, however, the natural drainage is somewhat deficient, and over such tracts the soil is considered "cold" and backward in the spring, and crops are frequently injured or planting is delayed by an excess of moisture in the soil. Tile drains could be installed to advantage over these poorly drained areas. The soil on the whole retains moisture well and crops seldom suffer as severely from drought as on soils of the same texture where the topography is more broken.

The material composing the Merrimac silt loam is alluvial and was deposited as outwash plains and stream terraces by streams issuing from the ice sheet during glacial times. The beds of stratified sand and gravel found below the surface extend to a considerable depth, and at Antigo are known to be 58 feet in thickness. The underlying rock is granite. The gravel found throughout the section quite generally is from granitic and other crystalline rocks. The fine surface soil is the result of the grinding action of the glacial ice upon these

formations and the action of water, weather, and possibly wind upon the glacial débris. The stones and bowlders which occur in places were doubtless carried in by floating ice or by the advance of an ice sheet after the stratified material was first deposited. This latest ice action may also account in part for minor irregularities and undulations in the surface of the outwash plains.

The original timber growth on this soil consisted of hardwoods and hemlock, with a very plentiful scattering of white pine, and with a little Norway pine. Of the hardwoods maple predominated, with birch, basswood, elm, ash, and oak less plentiful. In the vicinity of Ormsby, in Langlade County, there is still a considerable tract of standing timber, but over most of the type the forest growth has been entirely removed and the land cleared.

By far the greater proportion of the Merrimac silt loam is under cultivation and highly improved (see Pl. XXVII). It includes some of the finest agricultural land in northern Wisconsin and the area about Antigo is the largest solid body of this type of soil in the State. The type of agriculture most followed at present is dairying in conjunction with general farming, with a strong tendency toward more extensive dairying, to which the region is well adapted. The chief crops are oats, hay, potatoes, and corn, with some barley, rye, and wheat. Peas are a special crop of importance, and to a less extent sugar beets are grown. Poppy seed is grown in many gardens, and ginseng culture is a special industry important in its returns. Rape is grown to be pastured by hogs.

The yields of the farm crops range about as follows: Oats, 60 to 65 bushels, with an average of 40 to 50; hay 1 to 3 tons, with an average of $1\frac{1}{2}$ to 2 tons; potatoes 125 to 300 bushels, averaging 150 to 200; barley 30 to 34 bushels, and rye about 30 bushels per acre. The varieties of corn best adapted to this region mature nearly every year, but corn is now grown largely for silage, and ordinarily gives 12 to 14 tons per acre. Wheat was formerly extensively grown, but the acreage at present is very small. The yields range from 20 to 30 bushels per acre. Peas are grown for seed and for canning. When allowed to mature the average yield is about 20 to 25 bushels per acre, though yields are extremely variable. The price obtained for seed peas is usually \$2 or \$3 a bushel. The canning factory frequently rents land for growing peas for canning, and when it furnishes all the labor usually pays about \$8 per acre cash rent. When the farmer does the plowing the rental is about \$10 per acre. Sugar beets yield 12 to 14 tons per acre and have a high sugar content. Some alfalfa is grown, but success has not been universal with the crop because of an acid condition of the soil and the need of inoculation with nitrogen-gathering bacteria. Ginseng is very profitable when skilfully handled and it is grown successfully on a considerable scale on this soil.

Probably the most common crop rotation followed at present consists of corn for 1 year, oats for 1, 2 or even 3 years, or oats followed by barley for 1 year. Timothy and clover are seeded with the grain, and hay is cut for 1 or 2 years, and the field may be pastured for a year before being again plowed for corn.

Little, if any, fertilizer other than stable manure is used, and this is usually applied to the sod land. This type of soil is not difficult to plow, as it is friable and works readily into a mellow seed bed. Fall plowing is desirable and quite generally practiced. It is most common where the texture tends toward a clay.

Improved farms on this soil sell for \$45 to \$100 or more an acre, depending upon the location and improvements. Wild cut-over land is worth \$15 to \$40 an acre.

Average results of mechanical analyses of samples of the soil and subsoil of the Merrimac silt loam are given below:

Mechanical analyses of Merrimac silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
311713, 311758.....	Soil.....	0.7	3.2	4.1	4.0	14.3	65.3	8.6
311714, 311759.....	Subsoil.....	3.0	11.7	12.8	7.0	11.9	44.8	8.7

MERRIMAC FINE SANDY LOAM.

The Merrimac fine sandy loam is of very limited extent and of minor importance. The largest tract, of several square miles, is found along the Brule River, about 8 miles northwest of Florence, in Florence County. Other small tracts occur in Germania and Almon Townships, in Shawano County.

The surface soil of the Merrimac fine sandy loam to an average depth of 8 to 10 inches consists of a light-brown fine sandy loam containing a comparatively small amount of organic matter. In structure the material is rather loose and open, but noticeably heavier than the Merrimac fine sand. The subsoil consists of a yellow fine sand which usually becomes somewhat coarser with depth and grades into a medium sand at 2 to 3 feet. In a few places the subsoil is found to be slightly sticky, owing to the presence of a small amount of clay, but as a rule the only difference between this type and the fine sand is the greater amount of silt and clay in the surface of the fine sandy loam.

The surface of this soil type is level to very gently undulating, and on account of the loose, open character of the subsoil the natural drainage is ample and usually somewhat excessive. It is probable

that when put under cultivation crops on this type will suffer from drought for a part of each growing season.

The soil consists of alluvial material which has been deposited as outwash plains, stream terraces, or old valley fill. Deposition took place during the last glacial period, when all streams were swollen and were carrying vast quantities of material in suspension. The parent material from which the soil was derived consisted chiefly of crystalline rocks which were ground up by glacial ice. There is no limestone material present and an acid condition exists in both soil and subsoil.

The original timber consisted chiefly of white and Norway pine, which growths usually indicate a better soil than land supporting jack pine. All of the timber has been removed and the land is now in stumps.

None of the Merrimac fine sandy loam has been cleared and put under cultivation. The distance from markets probably accounts for this, together with the difficulty and expense of removing the numerous pine stumps. When cleared this soil is well adapted to growing potatoes, rye, and beans, and doubtless a number of other crops, successfully. It should be less difficult to get a stand of clover on this soil than on the sand and fine sand types, and for this reason productiveness can be more readily built up and maintained.

MERRIMAC SANDY LOAM.

The Merrimac sandy loam may be considered as one of the types of minor importance in the present survey, since it occupies a total area of only 23.4 square miles. One of the largest tracts, embracing nearly 9 square miles, occurs along the Embarrass River and Mill Creek in Belle Plaine and Herman Townships in Shawano County. Directly northeast of Antigo, in Langlade County, there is a long narrow belt containing 7 or 8 square miles of this soil. Other small patches occur scattered over these two counties and also in Oconto and Florence Counties.

The surface soil of the Merrimac sandy loam to an average depth of 12 inches consists of a brown or light-brown sandy loam of medium texture. In places the texture approaches that of a sand, and could be classed as a loamy sand, but such variations are not extensive. The subsoil consists of a loose, incoherent yellow sand which becomes somewhat coarser with depth, and below 26 to 30 inches there is frequently some small waterworn gravel. In the lower layers this material is stratified. The material composing both soil and subsoil is in an acid condition.

The surface of the Merrimac sandy loam is level to very gently undulating, and because of the loose, open structure of the subsoil the natural drainage is ample and usually somewhat excessive.

Where the soil is under cultivation crops very frequently suffer from lack of moisture during part of practically every growing season. Where the type occupies a low terrace, as is sometimes the case, the water table is nearer the surface than typical and the soil is not so droughty.

The material composing the Merrimac sandy loam is of the same origin and was deposited in the same manner as that forming the fine sandy loam. The deposition doubtless took place during the advance and retreat of the last glacial sheet when a large quantity of water was being discharged from the ice. The parent material from which the type was derived consists largely of crystalline rocks, though there may also be a small quantity of material from sandstone. No traces of limestone are to be found, and both soil and subsoil are in an acid condition.

The original timber growth consisted of white and Norway pine, with varying amounts of birch and hemlock, and some maple. Jack pine is not found on this type. Over some portions of the type hemlock predominates, in other places pine.

While practically all of the timber of merchantable value has been removed from this soil, probably less than half of it has been cleared and put under cultivation. The type is adapted to about the same crops as the Gloucester sandy loam. Where favorably located as to shipping facilities, the trucking industry could doubtless be profitably developed. This soil is well adapted to potato growing and gives good returns where properly handled. On the tract northeast of Antigo, in Langlade County, general farming is practiced to some extent, with fair returns. Corn, chiefly for silage, hay, oats, rye, and potatoes are grown. The soil warms up early in the spring, responds readily to careful management and the application of fertilizers, and otherwise has a number of very desirable characteristics. The organic-matter content is low.

PLAINFIELD SERIES.

The surface soils of the Plainfield series range in color from brown to grayish yellow, while the subsoils are usually yellow to pale yellow. This series is developed in the deep drift-covered areas of Wisconsin, Michigan, and Minnesota and comprises soils formed from sandy and gravelly glacial débris washed out from the fronts of the glaciers. It is also developed as deep, filled-in valleys along streams, such as the Manistee and Au Sable Rivers in Michigan and the Wisconsin River in Wisconsin. The first phase occurs as nearly level or gently sloping outwash aprons connected with terminal moraines, while the second is formed by the filling in of valleys, often several miles wide, during periods of former glaciation. The greater part of the material of the series has been much assorted and

consists mainly of sand and gravel. The deposits are deep and the soils leachy and droughty. The fine sand and sand members of the series are mapped in the northeastern Wisconsin survey.

PLAINFIELD FINE SAND.

The Plainfield fine sand is quite widely distributed and is found in four of the counties surveyed. With its poorly drained phase it has a total area of 144 square miles. In Shawano County this type is confined largely to the Wolf River Valley, where it occurs bordering Shawano Lake. Another small tract lies along Embarrass River, in Belle Plaine Township, in Shawano County. In the central part of Oconto County there are a number of tracts, the largest of which occurs along the Oconto River, both north and south of Suring, while areas of minor importance are found along the western border of the county. In Florence County there are also several areas of this soil, ranging in size from 2 to 3 square miles. Large areas of the type occur in the southeastern corner of Marinette County and along the front of Green Bay, in Oconto County.

The surface soil of this type to an average depth of 8 inches consists of a yellowish-brown or grayish-brown fine sand. The material is loose and open in structure, the organic-matter content is low, and the soil is acid. The subsoil consists of a yellow fine sand to a depth of 18 to 24 inches, where it grades into a medium sand, which in the lower depths of the 3-foot profile frequently contains a small amount of fine gravel. The amount of organic matter in the surface varies somewhat, being greatest in places which are a little lower than typical and where the water table comes closer to the surface than usual. A few sand dunes are found upon this soil in places, but they are not of sufficient extent to be indicated as a separate type.

The surface of this type is level to very gently undulating, except in places where the wind has blown the fine sand into low dunes. In such places, which are of small extent, the surface is very gently rolling. On account of the loose, open structure of the soil and subsoil, the natural drainage is thorough and usually excessive. The type frequently suffers from drought, except locally where the water table is nearer the surface than typical.

The Plainfield fine sand is an alluvial soil which was deposited during the advance and retreat of the last ice sheet as stream terraces, or as outwash plains or deltas built into the glacial lake. The material was originally derived principally from sandstone rocks, with smaller quantities of crystalline-rock material. Since its first deposition the surface has been modified slightly by the action of wind.

The original timber growth consisted chiefly of white and Norway pine. Jack pine is scarce. The timber was all removed from this type years ago, and at present there is an irregular growth of poplar, sand

cherry, and white birch, with an undergrowth of sweet fern in a number of places.

Large areas of the Plainfield fine sand are not under cultivation, but near Oconto, Marinette, and Peshtigo it is utilized quite extensively. The crops chiefly grown are potatoes, rye, corn, buckwheat, beans, and hay. The yields average somewhat higher than those from the Plainfield sand, but the type does not have a high agricultural value and requires careful management to produce profitable yields. The soil is deficient in organic matter. The Plainfield fine sand warms up early in the spring, and where favorably located a number of early truck crops are successfully grown. Potatoes, cucumbers, beans, pumpkins, squash, strawberries, and bush berries all do quite well on this soil under efficient management.

Plainfield fine sand, poorly drained phase.—The poorly drained phase of the Plainfield fine sand is confined entirely to Oconto County, in Morgan, Chase, Pensaukee, and Little Suamico Townships. The greater portion of this phase occurs as one continuous, though somewhat irregular, area. Most of it lies between the Pensaukee and the Oconto Rivers, but a portion lies south of the Pensaukee.

The surface soil of the Plainfield fine sand, poorly drained phase, to an average depth of about 6 inches consists of a fine gray sand. In places the immediate surface has a brown or sometimes nearly black color, due to the presence of a small percentage of organic matter. The subsoil consists of a yellowish-brown or rusty-colored fine sand, which is sometimes mottled with gray in the lower depths. The texture frequently becomes coarser with depth, and at 30 to 36 inches a medium or even coarse sand may be found.

The surface is low and flat, and while a swampy condition does not prevail over the phase it is all poorly drained and in its present condition has a low agricultural value. Scattered throughout the large area of this soil are small patches which have a shallow covering of peat, but all these were too small to be indicated on the map in a general survey. The original timber was chiefly white and Norway pine. At present the growth consists of poplar, birch, hazel, and willow. A few farms have been opened on this soil, but most of these are not affording more than a mere livelihood for their operators.

The development of this class of land is hardly profitable at the present time. The land in its present condition is "cold" and backward and all crops get a late start in the spring. Drainage is essential as the first step in improvement, but even with drainage careful management is necessary to obtain profitable yields.

PLAINFIELD SAND.

The Plainfield sand occurs in five of the six counties included in this survey and covers a total area of 293.4 square miles, of which about 236 square miles is found in Marinette County, where it appears

in a number of irregular tracts 1 square mile to 20 square miles in extent scattered throughout the county, except in the western and extreme southeastern sections. In Oconto County the largest areas occur about 6 miles southeast of Mountain in Armstrong Township and in Maple Valley Township around Crooked Lake and White Lake. In Forest County there are several small tracts in the western and southwestern portions. In Shawano County the largest tract is found along the Embarrass River in Belle Plaine Township. In Langlade County there is less than 3 square miles, most of which occurs east of Post Lake, while in Florence County none of this type was mapped.

The surface soil of the Plainfield sand to an average depth of 8 inches consists of a light-colored, yellowish-brown or grayish-brown loose sand of medium texture. In the virgin soil there is frequently a slight accumulation of organic matter in the upper few inches, but after a few years of cultivation under the usual methods this largely disappears. The subsoil consists of a yellow, yellowish-brown, or grayish-brown loose sand of medium texture which usually becomes somewhat lighter in color and coarser in texture with depth. Below 24 or 30 inches there is often a considerable proportion of coarse sand and some fine well-rounded gravel. Litmus-paper tests and the nature of the vegetation indicate an acid condition of both soil and subsoil.

A quite common variation in this type occurs where the surface soil is a coarse sand. There are a number of such tracts in Marinette County, and the area south of Mountain, in Oconto County, is of this character. Such areas, however, are of comparatively small extent and are so closely associated with the medium sand that it is not considered advisable to make a distinction in a general survey. A texture slightly finer than that of the typical soil is another phase of the Plainfield sand. This is found in various parts of Marinette County. It is largely confined to regions where the surface is uneven and the material probably of wind-blown origin. Eskers containing large quantities of gravel are also found in Marinette County, but their total area is very small. Throughout northern Marinette County and in other localities where the underlying formation consists of crystalline rocks there are a number of rock outcrops and a few boulders scattered through many of the areas of Plainfield sand, though the type as a whole is free from stones and boulders. Where the underlying rock is sandstone there are no outcrops and very few boulders.

The Plainfield sand is locally known by such terms as "sandy land," "jack-pine land," or "sand plains."

The surface of the Plainfield sand where typically developed is level to very gently undulating. In Marinette County there is more variation in the surface than elsewhere, and to the southeast of High

Falls wind-formed dunes occur in such numbers as to impart a somewhat rolling surface. This same condition exists in other parts of the county, though to a smaller extent. Eskers and kames have been included with the type in a few instances, as none of these areas are more than a few acres in extent. On account of the loose, open structure of the Plainfield sand the natural drainage is ample and very often excessive, so that the field crops frequently suffer from lack of moisture. Where the type occurs adjacent to streams as a low terrace the water table in some cases lies so near the surface that the period when plants suffer from lack of moisture is considerably shorter than over most of the soil area.

The Plainfield sand where typically developed consists of alluvial material which has been deposited as stream terraces, valley fill, or outwash plains. The greater portion of the material was doubtless deposited during the advance and retreat of the last ice sheet which covered this region. The few kames and eskers which occur were deposited beneath the ice sheet, while most of the other irregularities in the surface of this type, such as the dunes, are due to the action of the wind. The gravel present in the subsoil and the boulders which occur over small areas are largely composed of crystalline rocks. These with the Potsdam sandstone make up the underlying formation and the parent material came largely from these sources. In a few instances limestone is the underlying formation, but it has no appreciable influence on the soil.

The original timber consisted chiefly of jack pine, which is the characteristic growth on this type, with some scrub oak and occasionally a little Norway and white pine. As an undergrowth the land is usually covered with sweet fern, blueberry bushes, and wild oat-grass. Portions of the type where the water table comes close to the surface may support a few hardwood trees consisting of maple and red birch and a little hemlock. No merchantable timber is found on this type now.

Only a small proportion of the Plainfield sand is under cultivation at present, but land is being cleared each year and new farms started. The type of agriculture most common consists of general farming, with potato growing and dairying as important branches. The chief crops grown and the average yields obtained are: Oats 20 to 30 bushels an acre, rye 12 to 15 bushels, buckwheat 15 to 20 bushels, hay about 1 to 1½ tons, potatoes 100 to 175 bushels, peas 10 to 15 bushels, beans 10 to 15 bushels, and corn 20 to 30 bushels per acre. Only a small quantity of corn is grown and most of it is cut for silage. The season is sometimes too short for corn to mature, but good silage can always be depended upon. Flint and the earliest varieties of dent corn will mature during most seasons. The type is well adapted to truck crops.

The rotation most commonly followed consists of corn or potatoes and oats or rye, followed by a hay crop, usually timothy and clover mixed. What manure is produced on the farms is most frequently applied to sod land to be plowed for potatoes or corn.

Because of the loose, open character of the soil it can be cultivated under a very wide range of moisture conditions, and no difficulty is experienced in putting the fields in good tilth. The productiveness of the type as a whole is low and the soil requires the best systems of farm management to build up and maintain its productivity.

The level topography of the land and the comparative ease of clearing it often impress newcomers, especially those from the prairie States, so favorably that they purchase farms on this type in preference to those supporting hardwood, although the prices may be nearly the same. Satisfactory yields can be obtained on the Plainfield sand year after year only by following systems of soil management which will keep up the organic-matter content.

The price of wild cut-over land of this type ranges from \$5 to \$20 an acre. Improved farms sell for \$30 to \$60 or more an acre, depending upon the extent of the improvements and the location.

FOX SERIES.

The Fox soils are gray to brown in color, with lighter brown to yellowish-brown subsoils, and occur typically on a level topography. When the topography is not level its variation is due to the occurrence of potholes or to the existence of valleys eroded since the formation of the plain or the deposition of the material. The material was laid down either as outwash plains or as terraces along streams within the glacial area or flowing out of it. It consists largely or wholly of glacially derived material, but contains a large percentage—probably 25 per cent—of limestone. The fine sandy loam is the only member of the series mapped in this survey.

FOX FINE SANDY LOAM.

The Fox fine sandy loam is one of the soil types of minor importance, occupying a total area of 10.9 square miles. The largest continuous area is found about 2 miles northeast of Gillett, in Oconto County. The other developments of this soil lie in the southern part of Shawano County, where it is confined to small, scattered areas in Waukechon, Hartland, Navarino, and Lessor Townships. The largest tract in this section, containing about 2½ square miles, is in the southeastern part of Waukechon Township and extending into Hartland Township. The other areas range from one-quarter to 1 square mile in extent.

The surface soil of the Fox fine sandy loam to an average depth of 12 inches consists of a light-brown or grayish-brown, friable sandy

loam which contains a rather low percentage of organic matter. The upper portion of the subsoil consists of a fine sandy loam somewhat heavier than the surface soil, or a brown sandy clay loam. At 20 to 24 inches this material grades quite abruptly into a light-brown fine sandy loam containing a high percentage of fine sand, and in places medium sand. The subsoil is stratified and beds of lighter textured material alternate with thin layers of fine sandy loam and sometimes of clay loam.

On the tract northeast of Gillett the surface is usually free from stones, but in a few places of small extent boulders 18 to 24 inches in diameter may be found to the extent of about 10 to an acre. In these same tracts there may also be found smaller stones 4 to 8 inches in diameter. In the subsoil some fine gravel may be found associated with the different strata, but the coarser gravel and small stones appear to be confined to the base of the sandy strata. While a small quantity of gravel occurs with the soil material, no large gravel deposits or beds were found underlying the type. The most extensive deposit occurs in the area 2 miles south of Bonduel, in Shawano County. About 40 per cent of the gravel in the soil and of the stones and boulders upon the surface consists of limestone.

As found in Shawano County the Fox fine sandy loam is somewhat lighter in texture than the description above would imply. The subsoil seldom contains material heavier than a fine sandy loam, except in the small area due south of Bonduel, where the tract as a whole approaches a loam. In Shawano County also the surface is practically free from all stones, and while a small quantity of fine gravel is frequently found in the deep subsoil it is not so plentiful as in Oconto County. About the same percentage of the gravel, however, is of limestone, and for this reason the material is classed with the Fox series.

The surface of the Fox fine sandy loam varies from level to very gently undulating, and there is frequently a very gentle slope toward the water course along which the type may be located (see Pl. XXVIII). Numerous slight rises appear at intervals of 10 or 15 rods and the difference in elevation within such distances is 2 or 3 feet. A few shallow ravines are found in Oconto County, chiefly about the margin of the tract, but erosion is not yet serious on this type of soil.

On account of the level character of the surface and the heavy subsoil of the Oconto County tract in places, the natural drainage is somewhat deficient, and tile drains could be installed to advantage over part of this type. In Shawano County most of this soil does not require drainage, although in places the water table comes so near the surface that tile drains would be beneficial, even though the subsoil is light in texture. Such tracts are "cold" and backward in the spring. The lighter portions of the type, especially where

slightly elevated, are subject to drought, and when improved and cultivated crops will doubtless suffer somewhat for lack of moisture during periods of each growing season.

The stones found upon the surface of the soil in places may have been dropped from floating ice during the glacial period or deposited by a second ice sheet which covered the area after the soil material had been laid down. The glacier in its advance scraped up portions of the underlying rock, and as most of this is limestone the presence of the limestone boulders and gravel can thus be accounted for. While the presence of the limestone in the subsoil keeps it from being acid, the surface material has been leached to a much greater extent and is frequently found to be slightly acid, especially in the more sandy portions of the type.

The original timber consisted of a mixed growth of pine and hardwoods. White and Norway pine, maple, beech, oak, and elm were all found upon this soil. On the heavier portions the hardwoods predominated, while on the lighter tracts pine was most plentiful. Practically all of the merchantable timber has been removed and where the land is not under cultivation there is now a growth of small poplar, birch, and white pine.

The greater proportion of the type in Oconto County is cleared and under cultivation (see Pl. XXVIII). In Shawano County probably one-third or one-half of the soil is cleared. General farming is the type of agriculture followed and dairying is the most important branch. The crops most commonly grown are clover, corn, rye, oats, and winter wheat. Average yields from the tract in Oconto County are about as follows: Corn, 35 to 40 bushels; oats, 50 bushels; rye, 20 bushels; wheat, 25 to 30 bushels; and hay, $1\frac{1}{2}$ to $2\frac{1}{2}$ tons per acre. Timothy yields are somewhat lower than clover. Sugar beets are grown as a special crop on a few farms and yields average about 15 tons per acre. In Shawano County the yields do not average quite as large, owing to the fact that the soil is somewhat lighter in texture.

A rotation followed by a number of the farmers consists of corn, oats, rye, or winter wheat seeded to clover, and timothy. Hay is usually cut for 2 years before plowing again for corn. On portions of the type the growing of hay has been carried on without proper attention to crop rotation until the productivity of the soil has been reduced. On such farms no live stock is kept and no elements of fertility are returned to the land. Wherever dairying is carried on and where there is the proper rotation of crops, so that some return is made to the soil, very good results are obtained.

This type of soil is one that can be readily handled and no difficulty is experienced in getting a good, mellow seed bed. Wherever the natural drainage is deficient tile drainage would permit of operations on the land earlier in the spring and give crops a considerable

advantage over tracts not drained, which would often mean the difference between success and failure.

The best improved farms on the Fox fine sandy loam range in value from \$60 to \$100 an acre. Where no clearing has been done and the land is located some distance from town, tracts can be bought at \$20 an acre.

POYGAN SERIES.

The surface soils of the Poygan series are dark brown to black in color. The series is associated with the Superior soils and is developed chiefly in the Upper Peninsula of Michigan, Wisconsin, and Minnesota. The soils are level to gently undulating in topography and occur in old lake bottoms, or in situations subjected to poor surface drainage for a long period of time. Only the fine sandy loam type is mapped in the northeastern Wisconsin area.

POYGAN FINE SANDY LOAM.

The Poygan fine sandy loam as mapped in the present survey is confined to one area of 15.4 square miles in the extreme southeastern corner of Oconto County. It occurs in a belt about 2 miles wide bordering Green Bay and extends from the southeast corner of the county northward for a distance of 8 miles.

The surface soil of the Poygan fine sandy loam to an average depth of 8 inches consists of a dark-gray to almost black fine sandy loam. The dark color is due to the content of organic matter, which is quite variable. Where the soil is gray, there is very little organic matter present and where black there is considerable. In some of the lower places there is a peaty covering a few inches deep over the surface, but when cultivated this becomes mixed with the mineral matter and in a few years nearly disappears.

The subsoil consists of a light-gray fine sand which extends to a depth of 24 to 30 inches, where a pinkish-red clay is usually encountered. This clay deposit contains numerous small angular rock fragments which impart a gritty feel to the material. In some localities where drainage is most deficient the clay has a bluish color, but is unchanged in texture. This heavy subsoil is composed of the same material as the Superior clay and the rock fragments consist almost entirely of limestone. The depth to the clay is quite variable and sometimes it is below the reach of the soil auger, though it seems quite certain that the whole type is underlain by it. In a few places the clay comes within 12 to 16 inches of the surface, but such areas are of small extent and in a general survey can only be referred to as a heavy phase. An area of this kind is found west of the railroad directly south of Little Suamico extending to the south county line, and another of small size about 1 mile north of Brookside Station.

The surface of the Poygan fine sandy loam is low and very nearly level. There is only a very gentle slope toward Green Bay, but this is usually sufficient to afford the necessary rate of fall for drainage ditches or tile drains. Owing to the level surface and low position, the natural drainage is deficient. The land bordering the bay is only a few feet above the water level, and in a number of places a marshy condition exists for some distance back from the shore. This is especially true along the southern part of the tract.

The clay subsoil underlying the Poygan fine sandy loam is doubtless of lacustrine origin, but the material has been modified by glacial action since its first deposition. The fine sand and fine sandy loam covering over the clay probably was washed down from the higher lands adjoining and deposited over the clay at a time when the waters of Green Bay were higher than at present. There is a very sandy low ridge running parallel with the shore about a mile inland, which appears to be an old beach line, and the western border of the type also marks a point at which the waters once stood. The clay subsoil is highly calcareous, but the dark surface soil is slightly acid in places.

The original timber growth consisted chiefly of elm, ash, and willow. All of the merchantable timber has been cut and where the land is not cleared a second growth, chiefly of willow, has sprung up.

Probably 50 per cent of this soil has been cleared and a number of farms are now in operation upon it. Fully half of the cleared portion supports grasses for wild hay, because it is so poorly drained that in its present condition it is not suited to the growing of cultivated crops. A number of open ditches have been constructed, but a much more extensive drainage system must be installed before the type as a whole can be utilized for cultivation. Corn, oats, and hay are the chief crops grown. A small amount of buckwheat and some potatoes and garden truck are also produced. Where the drainage is quite well established, fair yields are possible, but where it is deficient the soil is inclined to be "cold" and backward in the spring and yields are not satisfactory. When properly drained this can be made a good, productive soil. The trucking industry could be developed to a considerable extent, as the shipping facilities are good.

CLYDE SERIES.

The Clyde series is characterized by dark-brown to black surface soils and gray, drab, or mottled gray and yellowish subsoils, derived through deposition or reworking of the soil material in glacial lakes or ponds, the darker color of the surface soils being due to the high content of organic matter, caused by the decay of plants in the presence of water. The Clyde series grades into Muck and Peat on the one hand, and into such glacial-lake soils as the Dunkirk series on

the other, without very sharp boundary lines. They are distinguished from the Poygan soils by the gray instead of reddish subsoils, and from the Fargo in their general absence of calcium carbonate. The topography is level and the soils are naturally poorly drained. Only the loam type is recognized in this area.

CLYDE LOAM.

The Clyde loam is one of the least important types in the survey from the standpoint of acreage. It occupies 9.4 square miles and is confined to a portion of the area underlain by limestone. The largest area, covering about one-half square mile, is located 4 miles north of Oconto. Several smaller patches occur in Pensaukee and Oconto Townships in Oconto County. A number of small patches are also found in southeastern Shawano County, mostly in Lessor and Hartland Townships. The type usually occurs in long, narrow strips along stream courses, or in depressions where a marshy condition is approached.

The surface soil of the Clyde loam to an average depth of 12 inches consists of a very dark or black loam which contains a high percentage of organic matter. Frequently small areas occur which have a shallow covering of peat, but these are of such small extent and so shallow that plowing will mix the peat with the mineral matter of the lower soil and thus distribute the organic matter through the entire surface soil. The subsoil consists of a gray or bluish material of variable texture. The upper subsoil may be a clay loam or a loam which becomes lighter in texture with depth, grading into a gritty, somewhat sandy loam at 18 to 24 inches. The deep soil is often mottled with yellow or reddish iron stains. In some places the entire subsoil section may consist of a sticky sandy loam or fine sandy loam, which in turn grades into a sand or fine sand at about 30 inches. Subsoil of the heavier character predominates, however. Small, scattered gravel stones are common in the subsoil.

The position of the Clyde loam is always low and it is naturally poorly drained. It is level to very gently sloping toward the streams along which it occurs. The small tracts not found as bottom land along streams are usually saucer-shaped and frequently difficult to drain. Some of the type along streams is subject to overflow. Before this soil can be farmed successfully it must be drained.

The Clyde loam is partly alluvial and probably partly lacustrine in origin. The material was doubtless all derived from the glacial till which covers this region and some of this was derived from the underlying limestone. On account of the calcareous nature of the subsoils of most of the upland types in this portion of the area and the leaching which has taken place, large quantities of lime carbonate have been carried into these low-lying places. As a result the surface

soil of the Clyde loam is not acid and the subsoil is frequently quite calcareous. The gravel in the subsoil is largely limestone.

The original timber growth consisted chiefly of elm, ash, and soft maple, with some willow. All of the best timber has been removed, but there is still much willow and a number of larger trees of second quality.

Only a very small proportion of the Clyde loam has been cleared and put under cultivation. When properly drained it is well adapted to corn and hay, and oats may be grown successfully, although there is some danger from lodging. Sugar beets are grown on this type in some other districts and could doubtless be grown successfully here. In its present condition the Clyde loam as a type has a low agricultural value, but when drained and properly farmed its productivity will doubtless be equal to that of any other soil in the area.

MISCELLANEOUS MATERIAL.

PEAT.¹

Peat is found in every county in the area and in tracts ranging in size from a few acres to over 25 square miles. The most extensive tract occurs along Peshtigo Brook, in northeastern Oconto County. Other large areas occur in the southeastern part of Marinette County and in Navarino Township, in Shawano County. In northern Forest County there is also considerable Peat, but it occurs in a large number of bodies ranging from one-half square mile to about 3 square miles in size, rather than as an extensive tract. Throughout the remainder of the survey the Peat is found quite uniformly distributed, and it is associated with practically all of the types except the Spencer silt loam.

The material mapped as Peat consists of vegetable matter in various stages of decomposition. Much of the material is still in a very raw, fibrous condition, showing plainly the remains of vegetable growth from which derived. This raw, fibrous material is of a brown color, but the more thoroughly decomposed it becomes the darker is the color. That which is well decayed is usually black or very dark brown. Small quantities of mineral matter may be incorporated with the organic matter, but when this becomes sufficient to change the texture appreciably, the material is classed as Muck. In the extensive areas of Peat little or no mineral matter is found, except about the margins, where there is frequently sufficient inorganic matter present to form Muck. In such places where the area of Muck was small it was included with the Peat. A number of the large areas mapped as Muck in an earlier survey of Marinette County would under the present classification be mapped as Peat.

¹ See Bul. No. 205, Univ. of Wis. Exp. Sta., on The Development of Marsh Soils.

The depth of Peat is variable and ranges from 10 inches to over 20 feet. In practically all of the swamps where the area is a square mile or more in extent the Peat is over 3 feet deep. In many of the smaller patches there is a margin of several rods where the underlying material can be reached at 12 to 20 inches, while in the center of the marsh it will be over 3 feet below the surface. In some of these places, however, the entire tract is shallow, but when the average depth is 18 inches or over it has been mapped as Peat.

In the large swamps and marshes where the material is still raw there is very little difference between the character of the surface material and that several feet below the surface. Where conditions have favored rapid decomposition the material in the surface soil is frequently considerably darker than at lower depths. A profile section of such material may consist of from 8 to 16 inches of black, fairly well decomposed organic matter, underlain by a brown, or light-brown, raw, fibrous material extending to a depth of from 3 to 20 feet.

The material underlying the Peat is variable, and ranges from sand to silt loam or clay loam. In general it may be stated that the texture of the underlying material is determined largely by the texture of the upland soil in the vicinity of the Peat areas. Throughout the areas of silt loam the underlying material is unusually heavy and of a light-gray or bluish color. Throughout the sandy portions of the area practically always the Peat is underlain by a grayish or nearly white fine to medium sand, and in some instances there is considerable gravel mixed with the sand. One marshy area in northern Forest County was found to be underlain by a bed of marl.

The surface of practically all of the Peat areas is level or has only a very gentle slope toward the water course along which it occurs. This slope is nowhere sufficient to drain the excess moisture from the Peat without the use of open ditches. Most of the Peat areas are wet for the greater part of the year and there is often a few inches of water over the surface in the spring, when most of the heavy rains occur. There are a large number of the Peat marshes which lie on a sufficient slant to enable them to be successfully drained. In fact, it seems very probable that far the greater proportion of the Peat in the area is so situated as to permit of drainage. Up to the present time, however, only a very small proportion of it has been reclaimed. About 2 miles west of Marinette a number of farmers have formed a drainage district, and have drained a large area of Peat with a deep canal. Some difficulty has been caused by the filling in of the ditch by sand brought in by seepage waters from the sides. In many of the large marshes sand would not be reached in the bottom of the drainage ditches, so that this difficulty would not be encountered in all of the drainage projects. Aside from the above-mentioned tract,

only a few small tracts on individual farms have been drained and placed under cultivation.

The vegetation on the areas of Peat consists chiefly of tamarack, cedar, and spruce. On the shallow areas there is some ash and a little soft maple. Logging operations are now being carried on quite extensively in getting out the cedar and tamarack. There are a number of marshes which at present either do not support any timber or have only a scattering growth of spruce or tamarack. In most of these places the original timber has been completely destroyed by fire, though there are a few marshes which it seems were always treeless. On some of the open marshes there is now a growth of coarse grass which is cut for hay or matting, though in the majority of cases the vegetation consists of sphagnum moss, cranberry-bushes, and other moisture-loving plants.

Throughout the southeastern portion of the area, where limestone is the underlying rock formation and where the subsoils of the upland types are calcareous, Peat is seldom in an acid condition, or is only slightly acid, but in the region where the underlying formation consists of sandstone or crystalline rocks and the soils are made up entirely of noncalcareous material it is practically all very acid.

Agriculture is most highly developed in the southeastern and southern portions of the area surveyed and it is most likely in these sections that the Peat will first be reclaimed. The first step in reclaiming such tracts is through drainage, and the large marshes can be developed only through cooperation of the landowners and the establishing of drainage districts. Peat is extremely high in organic matter and nitrogen, but low in potash and phosphoric acid, and it is necessary to supply these elements by applications of commercial fertilizers.

When thorough drainage has been established and proper methods of cultivation are followed this type of soil is adapted to a number of crops, including corn, potatoes, cabbage, buckwheat, and timothy and alsike clover for hay. When the soil is thoroughly firmed by rolling small grains can be grown. Excellent tame-grass pastures can be developed on this land.

The peaty material itself can be utilized as a fertilizer for sandy soils and where tracts of Peat are adjacent to sandy land which is farmed it is profitable to apply the material in the same manner as stable manure.

MUCK.

The material mapped as Muck occurs in four of the six counties of the present survey, and while its extent is greater than that of several minor upland types, it is much less than that of the Peat. The greater proportion of the Muck is found in Marinette County, where it occupies over 175 square miles. The most extensive occurrence in this county is immediately to the south of the Wausaukee River and

to the east of Medicine Brook. In the southwestern corner of the county there is a tract of considerable size along Peshtigo Brook and in the southeastern portion a large tract extends to the northeastern corner of Oconto County. Other tracts occur throughout Marinette, Oconto, Shawano, and Langlade Counties, chiefly in narrow belts of lowland along streams rather than as extensive marshy areas.

Where most typically developed the Muck consists of black, well-decomposed organic matter with which there is incorporated an appreciable amount of mineral matter. The organic content represents the accumulated decaying remains of plants and the mineral matter the more or less finely comminuted soil particles carried into the depressions by the action of water or wind. In Marinette County this material extends to a depth of 3 to over 5 feet in a number of the larger tracts, but in the majority of areas, which are long and narrow, the depth is usually less than 3 feet and frequently not over 12 or 15 inches. The material mapped as Muck is variable, and while the above description fairly represents most of the type, there are included a number of small tracts which in a detailed survey would be classed as Meadow. Such areas consist of low, wet lands along streams, where the texture of the soil is so variable as to make a textural classification impossible. The material ranges from sand to silt loam and differs radically from the typical Muck in this respect. It, however, contains a larger percentage of organic matter than any of the upland soils and resembles the Muck in its topographic position, drainage conditions, and present value. It is practically all subject to overflow, as is much of the typical Muck.

In origin the meadow phase is chiefly alluvial and consists of material which has been washed from the adjoining upland soil and carried various distances by the streams before being again deposited in its present position. Each overflow adds a small amount of material to the surface of the type. Throughout the southeastern portion of the survey, where the underlying rock is limestone, where most of the subsoils of the upland types are calcareous, and where the greater proportion of the Muck occurs, the soil is not sour. In the portion of the survey underlain by sandstone and crystalline rocks, where the soils are all noncalcareous, the Muck is very sour.

Where the Muck is deepest the forest growth consists of cedar and tamarack, but where it is shallow and where Meadow is included the growth consists of soft maple, ash, alder, elm, and some willow. Some of the low, wet lands included with Muck are treeless and are called "hay marshes."

Only a few small patches of Muck are under cultivation, but when drained thoroughly and properly managed it will produce profitable crops of corn, potatoes, cabbage, buckwheat, and timothy and alsike

clover for hay. Small grains may also be successfully grown. Tame-grass pastures can be developed on these Muck areas with proper care. Muck is rich in organic matter and nitrogen, but requires applications of potash and phosphorus in the form of commercial fertilizers to keep up the productiveness.

ROCK OUTCROP.

There are a few localities in the present survey where the underlying rock outcrops to sufficient extent to make the land practically worthless for agriculture. The outcrops are not always in the form of one continuous ledge, but may occur in large numbers and so close together that the soil between can not be utilized for any cultivated crop. The soil is often so shallow as to have a low value even where of sufficient extent to be utilized. Where the outcrops are extensive symbols have been placed over the entire area so as to show the extent of this class of material. Where a single ledge outcrops and covers only a few square rods a single symbol has been used to show its location.

The most extensive and numerous outcrops occur in a belt running from the northeastern part of Marinette County to the vicinity of Mountain, in Oconto County, and these are associated with the Gloucester fine sand and fine sandy loam types of soil more extensively than with any of the other soils of the area. Numerous other ledges occur in southwestern Shawano County and along the Wolf River, in northern Shawano and eastern Langlade Counties. Practically all of the rock exposures are confined to the region where granitic rocks make up the underlying formation. There are no exposures of sandstone and very few of limestone.

Where the outcrops are most numerous and where the rock comes close to the surface the agricultural value of the soil is greatly reduced. Such tracts may afford pasturage for part of the year, or can be devoted to forestry.

SUMMARY.

The area covered by the reconnaissance soil survey of northeastern Wisconsin includes six counties, Forest, Florence, Marinette, Oconto, Shawano, and Langlade, and embraces a total area of 6,098 square miles, or 3,902,720 acres, located in the extreme northeastern portion of the State. The surface features are characteristic of a glaciated region, and the topography varies from level to rough and broken. Elevations range from practically the Great Lakes level to over 1,000 feet above. The highest portion is the Northern Highlands, where many important rivers of the State rise. Some of these through their rapid descent within the area afford much potential water power. The earliest settlement of the area dates back to 1786, but industrial activities did not begin until about 1832, when the

first lumber mill was started in Marinette. Lumbering was the most important industry for almost 50 years. Agricultural operations were not well under way until the seventies and farming could not be considered of much importance before the eighties, when the southeastern portion of the region surveyed was rapidly being settled and put under cultivation. Throughout the northern part of the area lumbering is still the most important industry, but agriculture is rapidly developing wherever the timber has been removed.

Three important railway systems traverse this region, providing excellent transportation facilities and connecting this section with some of the largest and most important markets of the Middle West.

The winters of this region are long and cold, but the summers are delightful, and all crops make rapid growth. Excellent water is available in all parts of the area, and the region is a healthful one.

Within the region surveyed all stages of agricultural development are represented. The southeastern and southern portions are well settled and highly improved, with land values ranging from \$50 to \$100 an acre for the best improved farms, while the northern portion is largely in virgin forests of hardwoods. Cut-over land can be bought for \$4 an acre and upward, depending upon the character of the soil and the location. The lightest sandy soil, originally covered with pine, has a low agricultural value, but the cut-over hardwood regions include much excellent land which offers exceptional opportunities for agricultural development. The chief crops grown at present are oats, hay, corn, potatoes, barley, rye, wheat, peas, sugar beets, buckwheat, and a number of trucking crops, the last being grown only to a limited extent. As reported in the census of 1910, Shawano County has 51.4 per cent of its entire area in farms, of which 44.7 per cent is in improved land. In Forest County only 3.1 per cent of the land is in farms, and of this only 21.7 per cent is improved. The other counties range between these two extremes in the extent of improvement. During the decade 1900 to 1910 the average value of farm property practically doubled. The type of farming chiefly followed at present consists of general farming in conjunction with dairying. At the present time there are 43 creameries and 116 cheese factories within the area, and the dairy industry is being gradually extended.

The region covered by the present survey, in common with all of northern and eastern Wisconsin, owes the general character of its surface to glacial action. The glacial drift which covers this region has been derived largely from the underlying geologic formations, of which there are six, and all of these have contributed to a greater or less extent in the formation of the various soils. Eleven soil series and 29 soil types, including Peat, Muck, and Rock outcrop, have been recognized and mapped in this survey. The material composing these soils has all been derived from glacial till, though some of it

has been reworked and redeposited by water and modified by the action of the wind or by the incorporation of organic matter since its first deposition.

The Miami series includes the light-colored, upland, timbered soils in the glaciated limestone region, and three types were mapped. The fine sandy loam includes some of the most highly improved farming land in the area. The fine sand is least valuable agriculturally.

The Fox series includes light-colored timbered soils of alluvial origin which have been formed in the glaciated limestone region as glacial outwash plains, filled-in valleys, or stream terraces. Only the fine sandy loam type was mapped in this survey. It is very inextensive but usually found under cultivation.

The Coloma series includes light-colored, timbered, noncalcareous upland soils in the glaciated region derived largely from Potsdam sandstone material. The soils are coarse in texture, and the three types recognized in this survey are not extensively utilized as yet, but are all capable of development. The organic content is low.

The Gloucester series consists of light-colored, noncalcareous, upland, timbered, glaciated soils where the material has been derived largely from crystalline rocks. All the types are in a more or less acid condition. The six members included range from silt loam to stony sand, and the series covers more than half the area surveyed. All the members except the sand and stony sand are important agriculturally, although only a beginning has been made in their utilization.

The soils of the Merrimac series consist of material derived from crystalline-rock formations, which was deposited late in the glacial period as terraces. Three types were recognized, the silt loam, sandy loam, and fine sandy loam. The silt loam is one of the best soils in northern Wisconsin and mostly under cultivation. The fine sandy loam is not utilized for farming.

The Plainfield series consists of light-colored, timbered, noncalcareous soils of alluvial origin, which have been formed as glacial outwash plains or stream terraces. The fine sand and sand are mapped in this area. The soils are low in organic matter, the poorly drained phase of the fine sand containing the most, but the sand is the type most extensively under tillage.

The Superior soils in this survey, the fine sandy loam and fine sand, consist chiefly of lacustrine material possibly modified by glacial action, the original heavy material having been overlain by light-textured deposits. The soils have a level surface and drainage is not thorough. The fine sandy loam is a good agricultural soil and extensively farmed.

The Kewaunee series is similar to the Superior in origin, but the former has a more uneven surface and better drainage as a result of glaciation. The three members of the series mapped, the loam, clay loam, and fine sandy loam, are all good agricultural soils. The clay loam is most deficient in drainage.

The Spencer series includes light-colored, timbered, upland soils from the older drift material, derived largely from crystalline rocks. Only one type, the silt loam, was mapped. This soil is most extensive in the north-central portion of the State and is comparatively important for its stage of improvement.

The Poygan series is of lacustrine origin and resembles the Superior, but the surface soil is dark colored. It is of limited extent, and only one type, of no great agricultural importance, the fine sandy loam, was mapped in this survey.

The Clyde soil mapped is the loam. This is high in organic matter, occupying old lake beds, drainage channels, and ponded valleys. It is partly alluvial and partly lacustrine in origin and is calcareous. It is inextensive and only a small proportion of it has been cleared and tilled.

Peat and Muck include areas of organic deposits in varying stages of decomposition. Much of the area covered by these soils can be drained and used to great advantage for farming. Peat and Muck cover one-sixth of the entire area surveyed.

Rock outcrop includes exposures of the underlying bedrock of such extent or so numerous as to preclude tillage. It covers large areas.

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